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CYBERNETICS, COMPUTERS AND AUTOMATION TECHNOLOGY

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GENERAL

IMPROVEMENT OF INFORMATION COMPUTER CENTER EFFICIENCY

Moscow EKONOMICHESKAYA GAZETA in Russian No 31, Jul 82 p 15

[Article by Yu. Dvornichenko, Department Head of Multiple-User Information Computer Center, Oblast Services Administration: "Provide a Full Load to Computers"]

[Text] The operation of the information computer center is judged differently. Some place the main point on such an indicator as the computer load (the number of operating hours of the computer per day), some judge it by the number of problems solved and others talk about the saving or about the volume of work performed. Thus, the main indicators of information computer center operation engaged in cost accounting are the computer load and the volume of work. Moreover, the second indicator is constantly a direct function of the first: the more hours the computer operated, the greater the profits of the IVTs [information computer center].

In this case no one is interested how the computer load is achieved and in the methods used to solve problems. Moreover, far from efficient operation of the computer is hidden behind such planned loading. And regardless of how paradoxical it seems, it is the main hindrance to conversion of information computer centers to multiprogram modes of computer operation and this means more effient use of its capabilities.

Are cost-accounting information computer centers, having a planned load, interested in reducing the problem-solving time on the computer? Of course not. To reduce the time of solving a problem, for example, by one half means to receive one half the monies from the customer for whom the problem is being solved and accordingly this means a decrease of profits. On the contrary, an attempt is made at this information computer center to "draw out" solution of problems in time and "to run" them in circles so as to overfulfill the loading plan.

How then are the collectives of information computer centers, located both on the budget of the enterprise and in cost accounting, to be stimulated and how is an expensive and high-speed computer to be operated more efficiently and rationally with maximum return?

I feel that the problem will be solved if the "load" indicator is replaced with the indicator of "coefficient of carrying capacity." It can be calculated by the ratio of the problem-solving time on the computer (in hours) to the saving from introduction of the problem (in thousands of rubles). The lower the coefficient of carrying capacity, the more efficiently the problem is solved on the computer in time.

The general coefficient of computer carrying capacity in this case will be equal to the ratio of the total time of solving all problems at the information computer center to the total saving. A decrese of the total coefficient of carrying capacity with a more intensive increase of the number of problems solved should become the most important condition for increasing the work productivity of the information computer center and efficient use of the computer capabilities.

Replacing the "load" indicator by the "coefficient of carrying capacity" indicator will obligate the collectives of the information computer center to reduce the costs of a machine-hour and to reduce the time of solving each problem.

6521
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MAKING COMPUTERS INTERFERENCE-FREE REPORTED

Vilnius SOVETSKAYA LITVA in Russian 26 May 82 p 4

[Article by Yu. Stroganov: "To Make Computers Trouble-Free"]

[Text] It would seem that the developers of computer equipment have provided everything for dependable operation of their children. They tested the machines with vibrations and impacts, heat and cold and determined the conditions under which computers are supposed to operate reliably. And still there are frequent cases when a malfunction unexpectedly occurs in their operation.

The secret of the "misbehavior" was simple. This was due to accumulation of static electricity on the operator.

Scientists of the special design office (SKB) of the Vilnius Production Association Sigma explained that this is far from the only "caprice" of this type in computers. Computers also respond to changes occurring in the electric power supply system, to pulsed electromagnetic fields and to the emissions of other equipment. In order to make the machines less susceptible to interference, the causes of malfunctions had to be studied and classified. The interference had to be simulated so as to test the computer for reliability and to adopt measures for stable operation of them.

A group of authors--department head, Candidate of Technical Sciences I. Gurvich, chief project designer, Candidate of Technical Sciences B. Korneyev and the leading designers K. A. Vencius and V. Samuitis--developed the corresponding measuring and simulation devices and classified interference and as a result taught the machines how to control it. The complex of investigations conducted by the Vilnius scientists received high marks at the institutes of the USSR Academy of Sciences--the Institute of Precision Mechanics and Computer Technology and the Institute of Control Problems.

Colleagues of the SKB also worked out methodical materials in which a method is provided for protecting computers of the SM series against interference and emissions. The importance of the group's activity is indicated by the following facts. A few days ago these materials were sent to CEMA countries who produce computers of the SM series: to Poland, Bulgaria, Hungary, the CSSR, Rumania and to Cuba. And the entire cycle of investigations conducted by the Vilnius scientists under the title "Guaranteeing the Electromagnetic Compatibility of Computers" (1968-1980) has been presented for the title of State Prize of the Lithuanian SSR in the field of science and technology.

6521
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COMPUTER TIME OFFERED TO USERS

Moscow TRUD in Russian 17 Jul 82 p 2

[Article: "Machine Time Made Available"]

[Text] The problem article published in TRUD, 13 April 1982, was titled "Machine Time Offered." It was discussed in it that the capacities of many computer centers are not fully utilized and expensive equipment stands idle.

The chief of department of computer technology of USSR Gosplan R. Ashastin and the chief of the Main Administration of Computer Equipment and Control Systems, GKNT [State Committee for Science and Technology], V. Myasnikov answered the editors. The criticism advanced in the newspaper was recognized as correct. The corresponding recommendations have been prepared for further improvement of computer utilization. It was provided in them that, beginning next year, all the activity of computer centers throughout the ministries and agencies of the USSR and Councils of Ministers of the Union Republics will be planned as an individual type of work.

The USSR TsSU [Central Statistical Administration] has been entrusted with creating an All-Union Association for Information and Computer Servicing. Beginning this year, seven territorial collective-use computer centers based on the VTs [computer center] for state statistics, will be developed. A procedure will be established by which computer centers and similar organizations for information and computer servicing will be created only through coordination with USSR Gosplan and USSR TsSU. These measures will permit the creation of new computer centers to be monitored and will increase the operating efficiency of existing centers and organizations.

The chairman of GKNT G. I. Marchuk decided to hear the question of increasing the utilization efficiency of computer equipment in Moscow during the third quarter of 1982 at a meeting of the board of the USSR State Committee for Science and Technology.

6521
CSO: 1863/234

EFFICIENCY OF COMPUTER USE QUESTIONED

Tallinn SOVETSKAYA ESTONIYA in Russian 8 Jul 82 p 3

[Article by I. Gudim, head of operational dispatcher department, Republic Collective-Use Computer Center, Estonian SSR Central Statistical Administration: "With a Profit or Loss"]

[Excerpts] The YeS-1022 models (the smallest of the computers of this type in the capability of using unified software) of the unified computer system costs 500,000 rubles together with the supplementary equipment, without which it cannot operate. We note that this computer does not have devices for combining into a complex and for intermachine exchange of information (the "old" models having these devices are considerably more expensive). Several tens of square meters of production area equipped with devices for automatic maintenance of the necessary temperature and humidity and cleaning of the air to a content of 350 dust particles measuring no more than half a micron per liter are required for the YeS-1022. That is, conditions of the assembly shops for production of radio tubes or transistors and better cleanliness than a surgical operating room must be created. Otherwise the external memory devices of the computers with their magnetic disks and tapes, like some units that require stable temperature conditions, will break down during operation and the machine will be rejected. In other words, construction of computer centers and of auxiliary rooms in a hurry does not guarantee stable operation.

The computers of the unified system should be serviced in three shifts by not less than 40 highly qualified programmer specialists, electronic engineers and operators. One cannot get along without workers involved in transfer of documents written by human hand to punch cards, perforated tape, magnetic tapes and disks on special machines: the computer can "read" the information only by using them. There are also the administrative apparatus, suppliers, sanitary engineers, electricians, cleaning women (an especially important figure near the "clean area" of a computer) and so on. It is natural that this collective should work with a full return and should provide a profit on the most complex and expensive equipment. "Economics should be economical." This phrase became the catchword after the 26th CPSU Congress. However, only every fourth of the computer centers (subdivisions operating computers) existing in the republic is on a cost-accounting basis with independent budget. According to accounting data, only 10 computer centers among the cost-accounting centers had a profit in 1979, while the remaining ones had a loss of 989,700 rubles to the national economy. Six cost-accounting computer centers had a profit in 1980 and the remaining centers also operated at a loss.

How did this happen? Are the enormous losses inevitable? Analysis of the use of computers in the republic shows that, together with specific success in conversion of engineering and technical calculations and accounting work to computers (the volumes of this work doubled during the period 1975-1980), there are very significant deficiencies. And this is primarily due to the fact that narrow agency interests predominate over general state interests and there is also no propert coordination in organization of computer centers.

It is very simple to obtain a computer: it is sufficient to present a request to a superior organization. Computers have become the object of prestige consumption. The presence of a computer gives "solidity" to an enterprise or to an institution and indicates a "modern" style of management, although the real indicator of th modern style of management should be the economic and social feasibility of implemented organizational and technical measures.

The decree of the Estonian SSR Council of Ministers "On introduction of computer equipment into the national economy of the Estonian SSR and development of automated control systems" was published as early as January 1971. The decree obligated 14 ministries and agencies of the republic mainly to make use of the services of the computer centers of the Estonian SSR TsSU [Central Statistical Administration]. The computer system of TsSU was developed at that time and had its own enterprises with experience in servicing organizations of different sectors at 12 rayon centers and in the capital of the republic. Thus, fulfillment of the decree with fractional participation of the ministries and agencies in development of this network more than 10 years ago laid the bases for more effective use--collective use of computer equipment.

Now 13 of the ministries and agencies named in the decree have their own computer centers and some of them are developing their own agency computer networks! I repeat, this situation was created not because the technical base of the computer system of TsSU was unable to meet the needs for information processing with the intensive development. Narrow agency interests one. Development of computer equipment in the republic proceeded by a sharp increase of the number of new computer centers and installed computers. Naturally, the intensive growth of the numbers of personnel and administrative-management apparatus accompanies this. A total of 73 percent of all computer centers and more than 74 percent of computers existing in the republic is concentrated in Tallinn. The total number of computers increased twofold and the number of computer centers increased 1.5-fold during the 10th Five-Year Plan. The number of computer center personnel doubled during this time and the administrative-management apparatus comprises almost one-fifth of it. There is also another characteristic detail: the computer capacities (number of operations performed by a computer per second) increased by 19 percent in Tallinn during 1981 alone. And this load (calculated in operating hours per day) remained at the same level during the entire 10th Five-Year Plan and comprised only 60 percent of the minimum norm. And the main reason for this is creation of small local computer centers with physically obsolete stock of computers and idle times of computers due to an absence of work. Last year the idle times for this reason comprised 4 percent of the total useful machine time and increased almost 1.5-fold since 1980 (useful machine time is the time

paid for operation of a computer. The cost of one machine-hour of a YeS computer is an average of 100 rubles). And the idle times during the year increased by an average of 14 percent for the latest and most powerful YeS computers.

More idle times also occurred due to technical malfunctions (by 9 percent). This indicates that the Tallinn Scientific Production Center of the Association Algoritm is still not completely coping with its main task--complex centalized technical maintenance of computers.

One of the serious deficiencies in use of computers is dispersion of labor resources in low-capacity computer centers, due to which a seeming ever increasing shortage of qualified programmers and electronic engineers appears. They are being converted to administrative-management personnel with organization of new computer centers and the number of workers without a higher education with a specialty will increase at the computer center. Interest in collective use of computer equipment decreases with development of local computer centers, while it is conversion to collective use of computers that is one of the basic directions of development of the national economy during the 10th and 11th five-year plans. But the agency position is unsupported. For example, the Estonian SSR Gosplan and TsSU, having reviewed the materials for substantiation of the need of the Estonian Scientific Research Institute of Animal Husbandry and Veterinary Science and of the Estonian SSR Minzhilkomkhoz [Ministry of Housing and Communal Services] for computers recognize that it was unfeasible to create computer centers at these organizations. However, last year both Minzhilkomkhoz and the institute received new machines. The Scientific Research Institute of the Estonian SSR Gosstroy also receives computers without coordination with the Estonian SSR TsSU.

Let us recall in this regard what happens when concern for conservation of state funds is disregarded in favor of agency ambitions. The ASU department of the administration of the fish industry of the republic numbers nine persons with annual wage fund of more than 15,000 rubles and two of them are involved directly in development of algorithms and programs. The Minsk-22 computer registered to it (the load of the computer in 1981 was only 3.1 hours per day) was leased to the kolkhoz Lyanene Kalur. The kolkhoz did not assimilate the machine and leases machine time from the computer center of the Estonian SSR Minavtoshosdor [Ministry of Motor Transport and Highways]. The Uprrybkhoz [Administration of the Fishing Industry] itself leases 180 hours of machine time annually from the computer center of the Estonian SSR Minzag [Ministry of Procurement] (which has a computer underloaded in operation) and counts how many cans are filled. However, it is planned during the current five-year plant to receive an additional two general-purpose computer complexes (minicomputers) and to further increase the number of personnel.

There is also a computer oriented toward the software of the unified system at the computer center of Estrybprom at Tallinn. Its load in 1981 comprised only 6.3 hours per day (canned goods were also counted among the miscellaneous tasks). What keeps the two adjacent ASU on the technical base of the computer center of Estrybprom from being combined?

The Estonian Republic offices of USSR Gosbank and USSR Stroybank, each at its own computer center, process information essentially of the same banking operations. The computer load at the computer center of the ERK [Estonian Republic Office] of Stroybank was less than the norm last year. However, this computer center leases five hours of machine time daily on the side. The administrative and management personnel comprise approximately half the staff here. Nevertheless, it is planned to further increase the personnel and stock of computers during the five-year plan. The computer center of ERK of Gosbank, which also has considerable personnel with an impressive annual wage fund, plans to increase it by an additional 74 persons during the five-year plan and to obtain new computer equipment.

Machine time at the computer center of the Estonian SSR Minfin [Ministry of Finance] is leased from the computer center of the Estonian SSR Gosplan. In this case its own computers were underloaded last year and it is typical that 93 percent of the machine time was occupied with processing state insurance information, which was successfully processed by the republic collective-use computer center of the Estonian SSR TsSU prior to organization of this computer center.

A centralized ASU of finance and credit bodies is now being developed. If all the technical capabilities are utilized, they will more than support the calculations of Minfin itself and the republic offices of Gosbank and Stroybank. A multiple-user regional computer center will be achieved.

But let us take such an area as science. The Institute of Cybernetics, Estonian SSR Academy of Sciences, has the republic's largest YeS-1052 computer and part of the El'brus-1 computer complex has already been received. The YeS-1052, which can be loaded not less than 20 hours per day, had a daily "shortfall" of almost nine hours last year. Why then do four other academic institutes located in Tallinn have their own computers? All their needs could be provided by the computer center. It is not understandable how the Institute of Economics of the Estonian SSR Academy of Sciences, for example, did not make a similar suggestion. Incidentally, it also has a computer center where only a little more than half of 32 persons have a higher education and five of them are also not working in their specialty. The problems being solved here on computers (not scientific problems, but the task of how to account for materials and wages for enterprises and leasing of machine time to the Estonian SSR Gosplan) required more than a third of the machine time in 1981 and the computer load comprised 65 percent of the planned load. What can one say! And after all, according to economic indicators, the computer center of the Institute of Economics is supposed to be a model for others.

How can one explain, for example, the reason for the existence of two computer centers on the territory of the Tallinn Commercial Maritime Port--its own and that of the Estonian Maritime Shipping Company equipped with identical computers and even solving problems of the unified project of OASU [Automated Sector Control System] of USSR Minmorflot [Ministry of the Maritime Fleet]? Apparently, this is also because of agency "prestige." Combining these two computer centers can only be beneficial and can provide a considerable conservatio of funds.

The TPC Punane RET already mentioned was a user of the collective-use computer center of the republic TsSU and was successfully serviced with a computer remotely through the equipment of user stations. And even so envy developed here: the association broke the agreement and created its own computer center with a staff of 60 persons and plans to add and additional 35 to them during the five-year plan, to obtain another computer and so on.

What measures are required for efficient use of scarce personnel and for increasing the level of work in use of computers? They are quite obvious from the foregoing. But we still assume it necessary to emphasize that establishment of strict control over an increase of the utilization efficiency of automated control systems and computer equipment in the republic will help matters. The subdivisions of ASU not having computer time for the given moment should be attached to existing computer centers of their own sectors with underloaded computers. Coordination of the use of computer equipment should be intensified and transfer of computer operations from obsolete computers to new ones should be accelerated. And finally the notorious agency barriers should be broken. Low-capacity computer centers should either be combined during 1982 on the territorial principle or on the line of agencies solving complex programs. The freed equipment can be transferred to those republics where there is a real need for it. Each computer center should become a cost-accounting center and should show a profit.

The industry of our country has quite stably assimilated the production of information teleprocessing equipment. The elimination of low-capacity independent computer centers on this technical base and organization of multiple-user computer centers based on them will permit a qualitative rise in the level of information processing in all sectors and will result in implementation of the tasks posed by the 26th CPSU Congress: "Increase the quality and efficiency of management labor. Guarantee further development and an increase of the efficiency of the network of automated control systems and collective-use computer centers."

6521

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UNDERUTILIZATION OF AUTOMATED CONTROL SYSTEMS REPORTED

Moscow PRAVDA in Russian 23 Aug 82 p 2

[Article by Candidate of Technical Sciences O. Gromyko: "Why Are Automated Control Systems Operating at Half Effort?"]

[Text] I recently visited a plant where 10 years ago we turned over one of the first automated enterprise management systems in the sector. It permitted one to calculate a detailed plan of shops for the month and the need for basic resources and to maintain operational accounting of the course of production. As a result, "lack of completion" was reduced by a factor of two and the rhythm of shop operation was increased. We had a total of seven developers armed with a single Minsk-22 computer.

Now there are approximately 100 developers plus operators in the ASU department, four modern computers are operating and display equipment and the SIOD-3 data base control system have been assimilated. What new things has the powerful computer complex brought to the managers of the services, shops, sections, planners and economists? It turned out that little has changed here.

Unfortunately, ASU with small expenditures on them rather frequently do not bring an improvement in enterprise management and the saving from them remains conditional.

What is the main cause here? During the past few years the capabilities of computer equipment have incrased significantly. The cost of one hour of operation of large machines has also increased. But as before, routine problems of the same class as before are frequently solved by using them and nothing is said about optimization of planning and analysis of production and economic activity using computers. A gap has formed between the capabilities of the computer and the low level of many ASU.

The fact is that their development and introduction, which were initially thought of as a temporary phenomenon (let us design, introduce and work at a new qualitative level!), were transformed into a permanent process of design, finishing and development of control systems. It was calculated in one of the sectors that the expenditures for design of an ASU became a permanent expense item of many enterprises and comprise 100,000-150,000 rubles annually.

This occurs primarily due to the fact that each enterprise and institution hardly develop an ASU independently. There are also costs from this: low efficiency, large expenditures, long design and introduction deadlines and "lack of coordination" of systems of different levels and agencies.

Database control systems and applied program packs have begun to be distributed during the past few years which helped to eliminate the named deficiencies. But introduction is occurring slowly. The fact is that it is difficult for the designer of any ASU to correctly select the appropriate database control system and applied program packs so that he has a poor idea of the system as a whole and moreover standard methods of tying in these devices to specific conditions have also not been worked out. Scientifically based and convenient information and algorithmic models have not been proposed for large, complex control entities.

I feel that one should begin with All-Union classification of control entities to be automated. Moreover, this should be done on the information-algorithmic principle when the community of algorithms and data structures is the basis rather than on the functional principle (ASU Pribor [Automated Management System for the Instrument Building Industry], ASU Gaz [expansion unknown] and so on).

There are not so many of these classes of entities. Database control systems and applied program packs should also be oriented toward them. The users also gain an advantage from this since they will have specific recommendations on selection of systems and the developer will have them since clear requirements will be given to him.

Development and introduction of modern data processing systems and methods of designing ASU are one of the timely problems of state significance. The head institutes involved in solution of it must allocate the necessary resources and financial means, sharply reduce design of nonstandard ASU and stop parallel development of ASU of the same type in different sectors--I feel that these are urgent measures.

But this is also not everything. In many cases the systems being developed do not have official customers, but the developers themselves assign the technical assignment to themselves. There are of course customer-users of the systems, which are the subdivisions of the enterprises and ministries. But their interests are frequently in contradiction with the requirements on the system as a whole. It is felt that regardless of who the designer is, there must be a special department, small but qualified, which will take on itself the obligations of customer of the ASU and will defend the interests of the organization for which it is being designed at all stages of development and introduction of the system.

The interests of the matter dictate the need to increase the requirements on the contract design, detail plans and the control systems themselves during acceptance by committees. The customer is frequently not sufficiently competent to influence the decisions selected by the developer in design of an ASU, while agency or state committees are incapable of making any changes

during the stage of acceptance of systems. Why not introduce state inspection of the quality of ASU, for example, attached to the USSR State Committee for Science and Technology, and why not entrust it to check the scientific and technical level of systems being developed?

Much also depends on the place allocated to the computer center in management of an enterprise or institution. If it is limited to routine accounting functions, then introduction of an ASU will be very difficult. And on the other hand, if computer centers take on themselves part of the functions of planning and accounting, they become participants in management of production and the success of introduction of the ASU is guaranteed.

And finally, what about personnel. Who develops the ASU? One effective person is the so-called supplier of functional tasks and the other person is the programmer. The first knows a narrow sphere of production or economic work (for example, planning of and accounting for raw material and materials) and the second knows machine programs. But neither one nor the other knows the system as a whole. A third section of developers (and the first insignificance)--the architects of the system, who have a good knowledge of the structure of the information flows and the data processing algorithms in the system as a unified mechanism, is also needed. Personnel of this profile are only beginning to be assembled.

Many institutes that train specialists for ASU do not acquaint the students with the development of data banks--the basic progressive form of organization and processing of information. Specialists in the field of management and economics of the national economy frequently have very approximate data on the capabilities of today's computers. Moreover, abundant experience in training specialists of different applied profiles who have knowledge in the field of programming, organization and data processing using computers, has been accumulated at some institutes, specifically the Moscow Physicotechnical Institute. It is felt that their experience should be used more extensively at all engineering and economic vuzes. This is especially important with regard to the beginning of the phase of extensive use of minicomputers, which are becoming a consituent part of the engineer's workplace.

Automated control systems affect the broadest layers of workers of the national economy and impressive funds are expended on development of them. The interests of the matter require serious rearrangement of the organization of development and introduction of ASU.

6521
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PROBLEMS OF AUTOMATED CONTROL SYSTEM DEVELOPMENT

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA EKONOMICHESKAYA in Russian No 3, May-Jun 82 pp 82-91

[Excerpts from article by V.M. Katkov and V.A. Petrushanskiy]

[Excerpts] This article discusses increasing the efficiency of automated control systems by using an integrated systems approach to developing and implementing automatic control systems at associations and enterprises. The trends in automatic control system development, the influence of automating control on the management mechanism and the improvement of the entire enterprise management system based on economical-mathematical methods and computer facilities are examined on the basis of practical experience.

At the beginning of 1981, over 5,097 systems with various functions were in operation in various areas of the national economy, including 2,040 automated process control systems (PCS), 1380 automated production control systems and 279 branch information systems (BIS).

Automatic control system development is characterized by a continuous increase in the number of systems developed, reduced developmental periods, reduced cost and increased efficiency. For example, during the 9th Five-Year Plan the Scientific-Research Institute for Control Computers and Systems introduced 75 systems providing overall savings of 23 million rubles, and 114 systems in the 10th Five-Year Plan with savings of 84 million rubles. During the 9th Five-Year Plan the Scientific Research Institute for Automated Planning and Control Systems introduced 48 systems providing savings of 21 million rubles, and 108 systems during the 10th Five-Year Plan with savings of over 60 million rubles.

An automated production control system was put into operation in 1977 at the Volga Automobile Plant (AvtoVAZ) which carries out more than 200 tasks and includes more than 1200 programs. The annual savings provided by this system amount to 3.9 million rubles. In 1979 the "Aktyubrentgen" plant implemented and automated technical production preparation systems providing annual savings of 820,000 rubles.

In 1978, the "ASU-Minpribor" [Ministry of Instrument Building Management Information System] provided savings of 30 million rubles, and the "ASU - Mingazprom" [Ministry of the Gas Industry Management Information System] - 40 million rubles. The use of a management information system by Gossnab SSSR alone provided 70 million rubles of savings in 1978, including more than 40 million rubles saved in transportation expenses.

The overall payback period for the resources invested in control system development does not usually exceed 2.5 years for production control systems, 1.5 years for technological process control systems and 3 - 3.5 years for branch management information systems. Savings exceeding 10 billion rubles were achieved over a relatively short period (1966-1978) by introducing automatic control systems within the national economy.

The advantages of automatic control systems and their high efficiency are obvious. Nonetheless, they are still not fully utilized. Many systems which have been accepted by commission and which respond to all of the requirements of the technical specifications do not play the required role in increasing the functioning efficiency of the overall management system of the enterprise. The actual savings from introducing control systems often does not reach the calculated levels, and amounts to only 14-25 percent for a number of enterprises [2].

Research done at 20 enterprises which were calculated to have high efficiency after the introduction of an automatic control system indicated that the commodity output dropped at two enterprises, the proportion of the management apparatus within the overall number of workers increased at 10 enterprises, the cost per ruble of commodity output increased at eight enterprises, worker idle time increased at six enterprises, overtime work increased at eight enterprises and unproductive losses increased at eight enterprises [3].

Analogous difficulties are also observed abroad. Estimates by experts have indicated that of all of the computers installed in capitalist countries only 20 percent are utilized efficiently, 40 percent are profitable only at full load and 40 percent are not economically justified [4].

In this connection, studying the technical, economic and organizational conditions for developing and operating automatic control systems, and problems of increasing their actual effectiveness, take on first priority. Further development of automatic control systems requires a thorough foundation of the causes of divergence between the actual and calculated effectiveness of automatic control systems, the low influence of automatic control systems on improving the overall management system and determination of future directions.

Estimating the actual effectiveness of an automatic control system is a complicated problem, since many of the automated system factors which influence technical and economic production indicators cannot be measured precisely. Existing methods for determining economic effectiveness do not establish the relationships between the sources of savings and the nature of the problems solved by the automatic control system and the structure of the system, and do

not allow for system performance. These methods make it possible in principle to operate very arbitrarily with the components of the savings, and to obtain "effective" systems, without delving into them substantively, by "correctly" selecting and combining these components [5].

The qualitative influence of automating control on the management mechanism depends completely upon the theoretical and methodological foundation which is implemented when the system is developed and upon the level of organization of all of the work involved in automating control. We shall discuss below some of the resistant trends and problems in automatic control system development which in our opinion reduced the effectiveness of automating control.

The most important methodological principle in scientific investigation of production control is the principle of integrity. During the initial stages of automatic control system development, the question of the advisability of a particular computer application was reduced to the question of its technical realizability, so that it became the responsibility of computer equipment specialists to provide the answer. Computer hardware, software and automated control systems themselves have undergone substantial development since then. Although under present conditions the technical realizability of an automated control system plan, together with the organizational, economic and technological support of automated control processes, technical specialists still have priority in determining the development and utilization of automated control systems and making management decisions. For this reason, questions involved in developing an automated control system are often pushed aside in favor of developing machine technology for processing production data in isolation from the overall problem of improving the management system. The algorithms employed by automatic control system developers reflect the traditional forms and methods of management which, having been held for a long time, make the existing system more conservative. Problems are mostly stated on the basis of the experience of the developer and the capabilities of the computer hardware rather than thorough scientific analysis of the entire production control system. For this reason, many important control tasks remain beyond the scope of the automated control system.

A one-sided view toward hardware and mathematical methods in improving management leads to excessive "technicality", which in turn brings about such negative phenomena as retaining traditional accounting and reporting forms, approaching the substantive aspects of control processes superficially, underestimating the role of management methods and complicating the interaction between organizations and subdivisions within the enterprise. The main goal of automation - increasing the effectiveness of the management system - is not achieved.

The question arises of the level of effectiveness which can be expected from automated control systems under these conditions. The automated control system is supposed to automate and optimize processes. If management processes are automated, their effectiveness cannot exceed the effectiveness of the management method itself. For example, if a system is intended to prepare and process planning-statistical and normative-reference documents, to handle bookkeeping, to compute payroll, etc., the savings are expressed only in

reduced labor for carrying out individual management functions. The introduction of automated planning and accounting for technological preparation of production based on network models, for example, is another matter entirely. In this case the entire process of preparing and assimilating an article is divided into stages, phases and operations in a straight logical sequence; tasks are planned in parallel and optimized in the network model everywhere possible. This produces significant savings, primarily through the use of new planning and management principles and qualitatively new approaches. The source of the savings in this case includes the management sphere as well as that of material production, since it is there that the new management decisions are directly implemented. The implementation time can be cut in half simply by executing tasks in parallel, i.e., disregarding the effect of automating and optimizing calculations. The effectiveness of an automated control system thus depends upon the effectiveness of the management methods. The method used to calculate the effectiveness of automatic control systems fails to connect these two important facets, which explains the significant divergence between the actual and calculated effectiveness figures. Anytime the development of an automated control system is based on existing traditional management methods, whose reserves have already been basically exhausted, the system effectiveness cannot be high. In addition, not enough significance is ascribed to the management methods and their organizational form in developing and implementing different types of automatic control systems. As a result, the systems, without touching upon the essence and management principles of organizational structures, automate only individual processes, engendering disproportions in labor productivity and the occurrence of bottlenecks, with all of the attendant consequences: complication of the implementation process, the appearance of psychological barriers and reduced economic effectiveness of the system.

The experience of the Volga Automobile Plant indicates that the management technique and the manner in which automated control systems are used are elements in organizing production management which must be tied into a unified system with the organizational structure, processes, information, methods and personnel. Experience has shown that without this integrated approach even the use of the most sophisticated computer facilities is ineffective [6].

Academician V.M. Glushkov notes that "the automated control system, of course, is not an end in itself. The ASU is an automated system, not an automatic one. The main thing is not the hardware itself, but rather the organizational aspects, which have not become especially clear" [7].

An integrated systems approach to automated control system development requires that both the economic-mathematical methods and hardware must be looked at as organic parts of a whole. However, this approach still has not been implemented widely because of the methodological and organizational insufficiencies in developing and implementing automatic control systems.

The Branch Methodological Guidance Materials for automated control system development reduces the organizational support process to analyzing the existing control system in order to provide a statement of the problems of automation [8]. The results of the organizational investigation are documented in the

statement of the complex of problems. The cost of pre-plan investigation together with development of the technical assignment does not exceed 2-5 percent of the cost of the planning work [5].

This arrangement of affairs makes it possible to single out, while investigating the enterprise, stable production processes involving routine repetitious operations and calculations which can be automated but do not provide the capability for a thorough scientific analysis of the entire enterprise management system or to note ways of improving it - the organizational process itself is aimed toward automating only individual local control processes. The Branch Guidance Materials do not pose the question of integrated improvement of the management system, and contain no provisions for documentation in which it might be reflected.

In our view, the goal of the pre-planning stage of an automated control system must be to create conditions for improving the enterprise management system on the basis of economical and mathematical methods and computer facilities; this process must start with the creation of new management principles, methods and forms on which the automation is based. Besides singling out reserve capabilities in control and production, the integrated investigation of the existing system must also try to find new organizational forms of production and control in order to implement a management mechanism which is built on a modern technical base.

Automation of administrative processes must be based on a thorough scientific understanding of management processes and extensive study of advanced production experience. Substantial research must be done on management organization, technology and methods, employing highly qualified specialists in this area, only then introducing automation on the basis of their findings.

Analysis of the organizational structures and composition of specialized scientific-research institutes and design organizations which develop and introduce automated control systems leads us to conclude that these organizations are not sufficiently prepared to solve these problems. No more than 30-35 percent of all of the workers within an organization are usually included in setting up tasks, and this figure is tending to become smaller. Many of the specialists among those who are involved have no practical experience in management work at enterprises: they work in integrated departments together with programmers, and are often under their direct supervision. Many large scientific-research institutes engaged in automated control system development lack research departments for management organization, technology and methods. This is why most automated control systems are implemented without a thoroughgoing organizational and methodological preparation of the enterprise for a fundamental restructuring of the management system.

The work involved in developing and implementing automated control systems within associations and at enterprises is also not aimed towards solving the fundamental problems of improving the management system. According to the Branch Guidance Materials, the automated control system department (computer center) is recommended as the authority to arrange for preparing the enterprise to implement the system, to participate specifically in the developments and

to monitor their progress, as well as the application and reliable functioning of the system.

Nonetheless, working out questions of the functioning, development and improvement of the management system and methods is the direct function and responsibility of the leadership of the association or management of the enterprise under the supervision of the director [9]. For this reason, the automated control system department is involved in practice primarily with automating existing management methods which do not involve fundamental questions of the organizational structure of the association or the principles used to manage it. However, as we mentioned above, the effectiveness of these systems is not very good. Experience shows that conscious acceptance by the top-level supervisor of the task of creating an automated control system is the deciding factor in its successful accomplishment [10].

Given this, how do we explain the need for an automated control system department, and what are its goals and functions? The implementation of an automated control system assumes specialization and centralization of data processing and ordering of data streams. In our opinion, the goal of automated control system activity is therefore to improve the information support of the management system and of design work. As a result of this primary goal, the automated control system department is responsible for improving management methods involved in the ordering of information processes; participating in system development and implementation; automating processes involved in data processing; developing algorithms and software programs; operating equipment and certain parts of the system, etc.

Concentrating the efforts of the automated control system department on solving the problem of management system information support changes the nature of the work of the department. Information support is now provided on the basis of the specific requirement of the functional tasks of the automated control system. For this reason, different systems build up different data bases at the same enterprise. Information is often duplicated for different ASU control systems. This leads to overlapping of information, which makes it much harder to update and correct. Information overlap is also observed between the automated and unautomated sections of a management system. This variety of sources results in an overall increase in the amount of information, makes it more difficult to manage and use and generates contradictions in management methods.

Under the present new conditions, information support is provided on the basis of rational functioning of the entire management system, since the control system department is specialized to handle data processing in the association. Improving information processes is the most difficult measure involved in rationalizing management systems, and must be done in close connection with those processes. The use of computers requires new information support methods: there are now three basic ways of improving information support:

1. Redistributing the amount of information work among production management levels, with larger volumes of work being transferred to lower and line units.

2. Employing the methods of economic informatics to improve the actual information support of a management system.

3. Mechanizing and automating information processes by using new equipment and computers.

The greatest success is achieved when all of these methods are used to improve information support. As we can see, two of these do not involve computers. For this reason, work on improving information support can and must begin before work starts on the automated control system. Consequently, the creation of an independent information department in a modern data-intensive production facility should not be associated rigidly with automated control system development. At the same time, the improvement of information support cannot be limited to questions of mechanizing and automating processes, which is sometimes the case during ASU development.

As an example, some ASU developers who have high-efficiency data processing equipment available send huge amounts of information to their supervisors, considering this to be an advantage of the system. In fact, however, this uneconomical dissemination of information, regardless of its timely production, makes the management process more difficult and complicated. In a different case, by using the deviation management principle in which a plan serves as the permanent information carrier, while current information consists of deviations from the plan, specialists at the Scientific-Research Institute of the USSR Central Statistical Directorate to reduce the amount of data transmitted by a factor of 16.6 in the branch current reporting system, with practically no reduction in the level of informedness of management. The cost of data transmission using the deviation method was approximately 7-8 percent of the cost of forwarding daily reports [11].

These examples, demonstrating the lack of effectiveness of automation when implemented without justification and the effectiveness of employing the economic informatics method, show how important it is to ensure a scientific approach, rather than a one-sided one, to developing the information support for a production control system.

The lack of a unified conceptual theory of the development of automated control systems and of general universal principles for their construction results in different understandings of the purpose of automated control systems and of the methods used to develop and implement them. Every ministry has its own lead scientific-research institutes for developing and implementing automated control systems which are responsible for coordinating projects and providing methodological support. Many independent approaches to the problem of automating management processes have thus arisen, which in the absence of an overall theoretical perspective of ASU development has lead to wide dissemination of individual design methods. At the same time, the broad front of ASU projects has engendered parallelism, a low level of unification and poor scientific foundation for the design treatments used.

Many institutes are developing the same systems and tasks in which the differences are neither significant nor fundamental and result not from the employment

of different management methods but from different structure of the data bases, input and output information and differences in the processing algorithm. Lack of clarity in the classification composition of ASU, subsystems and tasks and types of documents makes the system development and implementation process more difficult.

The effectiveness of automated control systems is determined to a great extent by the completeness and quality of the software. The structure of expenditures for design work demonstrates a stable trend toward an increasing share for software. The number of mathematician-programmers at ASU scientific-research institutes and design organizations exceeds significantly the number of people involved in establishing tasks, and is tending to increase still further. About the same is the case for ASU departments at enterprises.

Since software development costs exceed the costs for duplicating, installation and checking on each series system by a factor of 100-1000, as the sizes of series of like control systems increase the relative cost of the software drops sharply. However, the flexibility of automated control systems and their software is low; an extremely large share belongs to unique systems. This is directly because of the organization of the systems development process itself.

To begin with, there is no clear delimitation between the individuals who establish the tasks and the software developers. The common opinion is that the system development process can be speeded up by having the programmers and requirements agent work together. We cannot agree with this, because the work of the requirements agent and the mathematician-programmer differs in principle, and while their final goals are the same, their organization requires a clear division of labor and allocation of responsibility.

Modern programming technology cannot be realized when programmers are grouped functionally in small subdivisions, which produce, slow, expensive hand-made planning. This results in multilevel duplication of expensive, laborious work, the absence of any legal or administrative responsibility for the development of individual components and the entire complex of programs during various design stages, to irregularity in setting up the process, with too little work at the beginning and overloads in the concluding stages, to incorrect distribution and loading of scientific and technical resources and to a low level of automation of technological processes in program design.

The goal of the requirements agent is to use economic principles, thorough scientific analysis of management systems and modern, progressive management methods to isolate stable elements of the overall management process, to determine methods for formalizing them and adapting them to different production conditions. The requirements agent must bear full responsibility for performance in developing the technical programming requirements and the level of requirements distribution.

Once programs are considered to have been debugged autonomously, between 10 and 30 errors per thousand instructions are discovered due to the lack of clear formalization of the technical requirements for program complexes and

their components. Each error requires changing an average of 15-20 instructions, so that the program complex becomes 30-40 percent larger [12] during integrated debugging and testing. Under these conditions, methods and means are needed to provide the developer with a single understanding of the characteristics of the complexes of programs to be developed.

Centralizing programmers into large specialized subdivisions makes it possible to coordinate programs which have similar functions and solution methods in order to reduce duplication significantly. In order to do this, it is necessary to have a classifier and unified catalog of developed and tested program modules and groups of applications programs. The appearance of a set of programs which serve to solve a particular class of problems and which are adapted to the specific requirements of the largest possible number of users characterizes the transition from manual to industrial production of software. The user cost of modular software is approximately 10 times less [4].

In order to develop industrial methods of implementing automated control systems, the Ministry of Instrument Building has formed the "Tsentrprogrammsistem" scientific-production association which now has more than 400 applications program packages which have been developed by organizations around the country. Considering that only 6 percent of all enterprises have automated control systems, the importance of extensive implementation and maintenance of applications software packages, permitting automated control systems to be copied at different enterprises around the country, becomes understandable.

Software maintenance practices reconfirm the need for an integrated systems approach to automated control system development and for increasing the role of organizational and methodological aspects in system duplication. It seems expedient for an organization which is created to produce finished software to concentrate scientific efforts on integrated improvement of the management mechanism, assuming the use of economic and mathematical methods, improving information support and employment of computers, creating standard organizational plans for automated management methods, preparing and adapting packages of applications programs and program modules for specific production conditions, i.e., concentrating on supporting the distribution process.

In practice, software maintenance consists of correcting and modifying software, the cost of which is 3-5 times greater than the cost of the materials and of copying and testing programs. The "Tsentrprogrammsistem" scientific production association includes a scientific-research institute for ASU software; however, as in many other research and design organizations, there are no research subdivisions to analyze management organization, technology and methods. The local development of automation in isolation from organizational and methodological management problems does not respond to modern conditions for improving production efficiency.

Socialist industry is faced in the 11th Five-Year Plan with new major, urgent problems which cannot be solved without a program for eliminating existing contradictions and singling out unpromising trends in ASU development, increasing their effectiveness and converting the economic management system to

an efficient facility. An automated control system assumes an integrated solution to the problem of increasing management effectiveness, since system implementation is not associated simply with the employment of computer facilities and the use of economical mathematical models, but also with the introduction of progressive changes to the existing organizational structure and management methods, rationalization and clear regulation of document flow and the creation of new standards, the improvement of production and labor, principles of management accounting, economic and moral incentives for workers, etc.

An automated control system will be effective if their development employs an integrated systems approach and if the goal of the implementation is not simply the functioning of the system as part of a plan but rather the improvement of the management system, if the automated control system replaces the traditional system, rather than working alongside it or in parallel with it, growing out of the traditional system gradually as conversion is done on the basis of a unified methodological principle, a fundamental redesign of the management system and a subsequent set of purposeful measures to restructure the existing system to an automated one.

For this reason, the implementation of an automated control system must be accompanied by organizational planning. Organizational plan development is used widely as the basis for preparing the implementing automated control systems in a number of industrial branches, e.g., at enterprises of the Ministry of Tractor and Agricultural Machine Building [13]. This increases system effectiveness significantly, with most of the increase, amounting to 80 percent, coming from organizational measures [14].

Work must be expanded on standardizing organizational management plans; research on urgent problems of organizational planning must be arranged, generalizing and disseminating them through all-union, branch and enterprise standards; it is advisable to expand and increase the qualitative level of organizational planning work allowing for the capabilities and requirements of automated control systems. The necessary conditions exist for creating design organizations or subdivisions to provide integrated designs for the organizational-economic part of the management mechanism, including automated data processing systems. The task is to make organizational planning an obligatory component part of the implementation of automated control systems at an enterprise, which should ensure industrial dissemination of applications program packages built using the modular principle.

The development and implementation of automated control systems must be based only on the very latest management methods. The automation process itself, because of its high degree of organization and productivity, brings a great deal which is new and progressive to the management process. The implementation of automated control systems demands the classification and coding of technical-economic information, ordering of information streams, the construction of information models, analysis, refinement and formalization of management tasks and the construction of a normative base. All of these areas are prerequisites for improving management methods and approaches.

The development of a classification and coding system makes it possible to convert technical and economic information to a form convenient for computer processing, as well as to order all information about the production medium, the production entities, the production relationships, to refine the nomenclature and interrelation between all elements of the production medium, to give it a quantitative estimate, i.e., to order and stabilize it, and in the future to obtain the capability of controlling it. The classification system opens up broad possibilities for such effective processes as unification, and grouping. It is important that these extend over the entire management system, and not just to individual processes which are subject to automation. The classification system requires unity of normative indicators, and can be used to solve problems of selecting the optimal production structure of a section, shop or plant, creates the prerequisites for improved series production of articles in small-series and series production, and supports the specialization of production, the introduction of production-line, mechanized and automated production processes [15].

The development and implementation of automated control systems should thus not be considered simply as a process of automating individual types of work, but as a qualitative jump in management methods and approaches. The correct choice of management methods making up the basis of this system is exceptionally important, since the level of effectiveness of the automated control system depends upon it.

Further improvement is needed in the way the process of ASU implementation is organized. The complex procedure of translating an existing management system to new organizational conditions and to new management methods with a qualitative change in the technical foundation of management processes cannot be reduced to filling and handing in technical documentation and organizing a computer center and ASU department. The entire management apparatus, under the direct supervision of the director, must participate in improving the management system.

In order for draft ASU treatments to be converted to an effective management means, they must be accompanied by organizational, economic and technological support. Organizational support assigns all procedures within the automated management process to specific subdivisions and executives and ensures that they are monitored and regulated. Economic support creates economic interest and a system for stimulating planned processes and projects. Technological support is aimed toward the development of the technology of automated management processes.

Explaining the principles of automation in the system technical documentation should be recognized as insufficient, since the draft documentation does not play an independent organizing role in improving management processes. The principles upon which ASU documentation is based represent only the potential capability of improving the enterprise management system. In order for developed principles to become real, they must be reflected in the organizational-directive, normative-technical and administrative documentation. Only then are the principles of automation transformed into a real management technology.

The new management tasks put forth by the present development of the Soviet economy require improvement in the methods by which ASU are implemented as well as a substantial deepening of automation processes. The solution to these problems depends to a great extent upon the degree to which the development of methodological foundations for creating and implementing ASU are directed toward the end goal of improving economic management processes.

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6900
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MICROELECTRONICS AND COOPERATION OF CEMA COUNTRIES

Moscow IZVESTIYA in Russian 12 Aug 82 p 5

[Article by Corresponding Member of USSR Academy of Sciences D. Zhimerin, First Deputy Chairman of USSR State Committee for Science and Technology]

[Text] Electronic equipment and the automated control systems developed on its basis have achieved impressive progress within a short time. The qualitative changes of electronic equipment have made it possible to use it in planning, control of individual units and production as a whole, in scientific research and in planning and design developments.

The development of electronic equipment in the Soviet Union began somewhat later than in some developed capitalist countries, but we have completely approached the worldwide level in quantitative and qualitative indicators in the sector as a result of vigorous measures adopted. As a result, practically all automated control systems (ASU) being developed in our country are equipped with Soviet computers and software. An exception are the peripheral devices produced in CEMA countries by intergovernment agreements or received with deliveries of equipment and complete sets.

Special success was achieved during the past few years in both the Soviet Union and abroad in microelectronics, which is the base for development of modern computers, peripheral devices and automation equipment. Successful development and organization of serial production of large and very large integrated circuits (BIS and SBIS), in which thousands of components are arranged on an area of several square millimeters, open new prospects in development, improvement and the use of computer equipment in all sectors of human activity.

New-generation computers having high speed of calculating operations, which number in tens and hundreds of millions of operations per second, are being developed on the basis of BIS and SBIS. In this case computers, by performing logic functions, free the programmer of need to detail the development of programs.

Microelectronics has opened real prospects for development of computers that "understand" or rather perceive and reproduce human speech. And this means that in the future this computer can operate by tasks assigned by voice.

The use of BIS and SBIS has made it possible to develop microcomputers and microprocessors. The difference of these devices from existing general-purpose or control computers consist in the fact that their dimensions and cost are reduced sharply, while comparatively high speed is retained. Thus, it became possible to design microcomputers which are capable of rather economical control not only of complex production processes or groups of interconnected units, but of individual machines, machine tools, etc. as well.

Microcomputers are of special importance in development of the production of robot manipulators in general and adaptive robots specifically. As is known, the delaying aspect of robotization was the fact that, without electronic control, robot manipulators could perform work only by a rigid program. Moreover, full automation and replacement of man during production required development of a robot capable of performing diverse labor operations. This adaptive robot was developed on the basis of microelectronics. This is a unique robot-"multimachine tool," which is capable of performing various functions by means of a microcomputer or microprocessor according to an established flexible program.

Devices for automatic control of many appliances, for example, electric burners and washing machines, were developed by using microprocessors; microprocessors can control injection of fuel into an automobile engine. Microprocessors are also used extensively in automatic telephone exchanges and equipment.

During the past few years, microelectronics has begun to be used with great efficiency in medicine as well. Thus, electric stimulators of heart rhythm, developed on the basis of integrated circuits an a miniature power source, save the life and control defects of the cardiac rhythm of thousands of people. Polyclinics will be equipped with diagnostic systems and automatic blood sampling and analysis systems based on the use of microcomputers during the next few years. The history of the state of health or medical history, entered in the computer memory, will permit the physician to retrieve all necessary data on a display screen within seconds.

The list of areas of human activity where microelectronics is already being used or may be used in the future is practically unlimited. Extensive introduction of microelectronics is now acquiring special timeliness during the 1980s when the increase of labor resources is slowing down and when the time requirement has become the fact that economics should be economical. However many obstacles and unresolved problems have been accumulated in the path of introduction of microelectronics. Among them should be distinguished the shortage of peripheral devices, software and also debugging and diagnostic equipment.

Combining the creative forces of the socialist countries in this area will make it possible to overcome the existing difficulties in production and use of microelectronics within short deadlines due to efficient use of the scientific and technical and production potential of the interested countries. Even more so since we CEMA countries already have many years of experience of this cooperation in the field of developing computer equipment.

In 1969 Bulgaria, Hungary, the GDR, Poland, the Soviet Union and Czechoslovakia and later Rumania and Cuba signed intergovernment agreements on cooperation in development, production and use of computer equipment in the national economy.

The technical level and volume of production of general-purpose computers (of the Ryad type), (small) control machines, microcomputers and microprocessors now guarantees the main needs of all countries of the community for them.

The problem of increasing the capacity of the main and external memories of the computers is being solved successfully by use of integrated circuits and large-capacity disks. Serial production of other external devices--automatic printing, displays, graph plotters and remote terminals--is also planned. The joint development of software is being organized and expanded. By the beginning of 1982, more than 100 applied program packs have been developed and are being used jointly. The use of programs developed by two or three countries became possible in the remaining countries of the community because the produced computers and peripheral devices are fully compatible technically, regardless of who produces them.

The dynamic development of computer equipment in CEMA countries is also the result of the activity of the Interngovernment Committee on Computer Technology, which, overcoming many difficulties, learned how to combine the creative efforts of scientific and technical personnel and production capacities. It is sufficient to say that more than 46,000 scientific and technical personnel and approximately 300,000 workers are involved in development and production of computer equipment in the participating countries of the community and that approximately 20 scientific research and more than 70 design organizations participate in implementation of coordination plans for joint operations.

Integration of the efforts of many countries makes it possible to develop and serially produce the entire range of electronic machines, external devices and programs within shore deadlines. The necessary replacement of computer generations is guaranteed because of this. Our countries are now successfully implementing the program for production of the Ryad-2 unified system, consisting of seven of the more modern models of computers and 80 types of peripheral devices. The development plan of the next, third generation of the Ryad-3 computers has been coordinated.

Similar work is being performed in the field of control computers. Production of small computers of new type, the CM-1420 and CM-1800, has begun. Together with organization of control computer production, more than 200 peripheral devices which are being produced or will be produced by CEMA countries have been developed or are underdeveloped.

The accumulated experience of the coordinated efforts in development and use of the latest equipment indicates the importance of further expansion and strengthening the cooperation of countries of the socialist community. This is especially necessary now when computer technology has received a new impetus for its development. A decision was made at the 35th meeting of the CEMA in 1981 on working out a program of cooperation on the problem of development and extensive use of microprocessor equipment in the national economy for 1982-1990.

To implement this decision, the secretariat of CEMA prepared a draft of the program which was considered and approved by the CEMA Committee on Scientific and Technical Cooperation. A general agreement was concluded in June 1982 on cooperation of CEMA countries in the field of microelectronics. Joint conducting of investigations in organization of cooperative production of a wide nomenclature of automated production complexes, machines and devices equipped with program-controlled microprocessor devices is provided in it.

The agreement envisions generalization of the accumulated experience in the use of microprocessor equipment and scientific research and experimental design work in development of microprocessor devices. Special importance is being devoted to personnel training and measures are planned to train and retrain specialists of higher and medium qualifications.

The program of cooperation contains more than 70 specific topics (tasks). A total of 52 pilot (standard) complexes and articles equipped with microprocessor devices should be developed and 28 complexes and articles will be delivered for serial production prior to 1990. Organization of the development of standard microprocessor systems by CEMA countries will permit acceleration of their assimilation in similar automated complexes by duplication.

According to preliminary estimates, the saving from implementation of the program during the period up to 1990 will comprise approximately five billion rubles. The saving will be achieved by increasing the labor productivity and by improvement of product quality and expansion of the functional capabilities and flexibility of control. A decrease of losses and reduction of energy and material expenditures are of no less important significance. The social significance of automatic control also cannot be disregarded: the nture of labor will be changed upon introduction of it and physical labor will be transformed to various types of mental labor.

Summarizing, one can state that success in development of microelectronics in combination with strengthening the cooperation of CEMA countries will guarantee a further rise and improvement of the socialist economy.

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MICROPROCESSOR TECHNOLOGY DEVELOPMENT AND APPLICATION AND COOPERATION AMONG SOCIALIST COUNTRIES

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[Excerpt from article by Yevgeniy Dudnikov, department head, International Scientific Research Institute for Control Problems, Vladilen Prokudin, department head, CEMA Secretariat and Boris Khaletskiy, consultant, USSR State Committee on Science and Technology]

[Excerpt] The CEMA member countries are placing major emphasis on the development and application of microprocessing technology. Many countries have accepted, and are successfully implementing, programs for more extensive introduction of the achievements of microelectronics - programs for integrated introduction of electronics into the national economy. However, the exceptional importance of this area for scientific and technical progress requires that the efforts of the socialist countries be combined on the base of a unified policy in the area of developing and applying microprocessor technology. Microelectronics is one of the seven priority regions of specialization and cooperation within the framework of CEMA.

With this in mind, the 35th Meeting of the Council Session in June 1981 instructed the CEMA Committee on Scientific-Technical Cooperation, with the involvement of the CEMA Standing Committee on Cooperation in the Area of the Radio Technical and Electronics Industry, the Intergovernmental Commission on Cooperation between Socialist Countries in the Area of Computer Technology and other CEMA agencies and international organizations of CEMA countries, to develop a draft program for cooperation among CEMA member countries for 1982-1990 to develop and implement microprocessor technology extensively in various areas of the economy.

The final goal of the program is the massive introduction to the national economy of systems, machines, instruments, equipment, etc. which employ microprocessor technology. For this reason, an inseparable part of the program must be the development of such systems for a sufficiently large number of areas in which the employment of this technology is effective.

This must be an integrated program, meaning that, in addition to developing applied systems for each area of application, it must also contain provisions

for the development of hardware and software to support these systems. An important section of the program involves the preparation and improvement of personnel in the area of microprocessor application, and popularizing and rendering consultative assistance on all matters involving microprocessor technology.

Applied systems should be developed by branch specialists who are thoroughly familiar with the singular features of specific applications, while microprocessor technology should be developed by specialists in the branches which produce that technology. The program must ensure cooperation between users who are developing applications systems and microprocessor technology producers. It must be kept in mind that there are specific requirements for each area of application but, at the same time, production requires unification of the component base, modules, peripheral devices and software. Consequently, a coordinated solution must be found as the result of joint efforts which responds to the capabilities of the microprocessor technology producers and satisfies the user requirements to the maximum extent.

In accordance with this, the draft program includes basic areas of cooperation:
--studying and disseminating experience gained in employing microprocessor technology in the economies of the CEMA member countries. These efforts will result in recommendations on setting up cooperation among CEMA member countries based on specialization and cooperation in production;
--developing microprocessor systems for various areas of the national economy in support of the most important, massive and efficient applications which can then serve as the base for the expanded introduction of microprocessor technology in individual branches, as well as setting up series production;
--developing microprocessor technology. This includes expanding the nomenclature of peripheral devices and software in accordance with user requirements;
--setting up a system for training and retraining specialists and creating national systems for teaching and consulting with microprocessor technology users.

Completion of the first section of the program will produce overviews of the status and trends of development and application of microprocessor technology which can then serve as the basis for developing recommendations for cooperation.

Projects under the second section are to provide prototypes of the corresponding systems or devices and to make recommendations for series production. Wherever these models are already in place and have been tested, their manufacture must be set up on defined scales based on division of labor and combined efforts among countries.

In accordance with the third section, peripheral and interface devices, devices for communicating with controlled objects and software which satisfy the user requirements indicated in the second section most fully will be expanded. There are also provisions for developing a large set of facilities for designing microprocessor systems which increase their efficiency significantly. This section also includes work to develop the microelectronic component base,

unified modules and families of universal microcomputers, to be carried out within the framework of the general agreement signed by the CEMA member countries in 1981.

The fourth section of the program contains plans to set up a network of courses to improve qualification ratings at universities, technical training schools and Academy and branch scientific-research institutes.

The draft program is made up of specific theme assignments which have been suggested by individual countries and included in the corresponding sections. These theme assignments have been analyzed in detail at a number of conferences of experts from CEMA member countries held in the fall of 1981 and the spring of 1982.

The CEMA Secretariat and the International Scientific-Research Institute for Control Problems took active participation in preparing for and conducting the preparatory work. The final version of the draft program was examined at the 25th session of the CEMA Commission on Scientific-Technical Cooperation in March 1982. That session also discussed the question of the forms of cooperation within the framework of the program and the implementation of an organizational mechanism for controlling its execution.

At the 103rd meeting held in April 1982, the CEMA Executive Committee adopted the draft program for presentation to the 36th Meeting of the Council Session, and instructed the CEMA Committee on Scientific and Technical Cooperation to prepare a draft general agreement to that end.

6900
CSO: 1863/211

SERIAL PRODUCTION OF ISKRA-226 COMPUTER COMPLEX

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 1 Aug 82 p 2

[Article: "New Computer Complex"]

[Text] Serial production of the Iskra-226 computer complex has begun at the Kursk Plant Schetmash. This machine is a new generation of computer equipment. The innovation is being produced in cooperation with enterprises of the GDR, Bulgaria and Poland.

6521
CSO: 1863/234

UDC 681.14

DESIGN OF COMPUTER COMPLEXES BASED ON UNIFIED COMPUTER SYSTEM AND INTERNATIONAL SMALL COMPUTER SYSTEM

Kiev UPRAVLYAYUSHCHIYE SISTEMY I MASHINY in Russian No 3, May-Jun 82 (manuscript received 28 Jan 81, after revision 4 May 81) pp 60-66

[Article by Candidate of Technical Sciences Gennadiy Petrovich Vasil'yev, Candidate of Technical Sciences Gennadiy Alekseyevich Yegorov and senior scientific associate Vladas Iono Shyaudkulis, Institute of Electronic Control Machines, Moscow]

[Text] The development of heterogeneous multimachine complexes (MMK) requires solution of a number of problems of guaranteeing the joint functioning of hardware and software of the computers to be complexed. These problems were solved in one or another form during complexing of the YeS EVM [Unified computer system] with M6000 [1, 2] and YeS1010 [3] minicomputers. However, realization of the program for creation and development of the SM EVM [International small computer system] resulted in the fact that the dominant position among small computers in different sectors of the national economy began to be occupied by machines of a given series. This in turn generated the need to develop MMK based on these minimachines and the YeS EVM.

Some problems of MMK design that include the YeS and SM-3 or SM-4 (hereafter simply SM EVM) equipped with OS YeS [Operating system of Unified computer system] and OS RV [Real-time operating system], respectively, are considered in this paper. Development of the methods for complexing these computers is a very timely problem if one considers the wide application of YeS EVM and SM EVM in production and in the nonindustrial sphere on the one hand and the prospects for development of computer networks based on them on the other hand.

Designation, functions, and areas of application of multimachine complexes. The considered multimachine complexes are designed to increase the efficiency and reliability of information processing with minimum special requirements on hardware and software. The characteristics of these multimachine complexes should guarantee the capability of using them in the following main spheres: integrated control systems for complex, including distributed entities (production processes, experiments and so on), multiterminal collective-use systems, systems for automation of planning and design work (automated designer positions), automated ticket reservation systems, savings bank management systems, material-technical supply control systems and so on.

The following general requirements on the functions entrusted to multimachine complexes are typical for the enumerated spheres of application:

--data entry into the complex at the point of its occurrence;

--data display to devices located at the point of use;

--access to systems archives from terminals;

--calculations in dialogue and pack modes;

--solution of optimum entity control problems with issue of control operations in real time.

From the viewpoint of the geographic location of computers, the enumerated applications require both local multimachine complexes in which data is exchanged directly over computer channels and distributed complexes that utilize commuhnications lines.

It is known [4] that two basic methods of complexing are used in these cases. According to the first of them, linked complexes are created: one computer is the main machine and the remaining computers are subordinate with limited functions. The second method is used in design of symmetrical systems. Expansion of the functions of subordinate computers to achieve symmetry results in significant complication of realization of multimachine complexes and control of them. In view of this and with regard to the requirements presented above on multimachine complexes, creation of complexes with limited functions of subordinate SM EVM and primarily their use as programmable user stations (AP) for YeS EVM is feasible for a number of applications.

The interaction of computers in these multimachine complexes can be organized by using different methods [1, 3]. One of the simplest and most effective of them can be regarded as simulation of specific devices of the YeS EVM on the SM EVM. This approach was used, for example in [1] to simulate devices serviced by the graphical access method and in [2], where a magnetic tape was simulated. The main advantage of the simulation method may be the fact that it does not require any changes of the software (PO) of the Unified Computer System. Since software developments of the Unified Computer System in these systems determine the maximum labor expenditures, one may assue that the simulation method is preferable to other methods in realization of the corresponding devices of the function sof the multimachine complexes enumerated above. Based on the condition of use of the standard software of the Unified Computer System in multimachine complexes, let us consider the methods of access and the devices supported by them in the YeS operating system for selection of those of them that can be simulated in the International Small Computer System.

Methods of access of the YeS operating system. One can now talk about the use of the following methods of access realized in the YeS operating system [5, 6].

The graphical method of access (GDM) is designed to perform input-output operations by using machine graphics displays and devices. The most widely used

devices whose operation is supported by GMD are group control devices with portable displays (YeS7906). From the viewpoint of use in multimachine complexes, the graphical method of access is characterized by the guarantee of computer interaction with local devices, i.e., subconnected directly to the channel of the YeS EVM.

The basic telecommunications method of access (BTMD) is designed for application in programs that utilize communication both with local and remote terminals (user stations). It permits one to work with low- and high-speed devices in the start-stop and synchronous modes. The BTMD permits the use of only semiduplex switched channels. The given method of access supports the following devices of the YeS EVM: AP-61, AP-63, AP-70, the YeS7920 alphanumeric data display system and also telegraph equipment.

The general telecommunications method of access (OTMD) is a development of teleprocessing eqipment of the YeS operating system compared to BTMD and exchanges data both with local and remote devices. In the latter case the use of switched communications channels in the semiduplex or duplex modes is possible. The OTMD supports AP-2, AP-4, AP-61, AP-63 and AP-70 user stations, the YeS7906 group control device with portable displays, the YeS7920 alphanumeric data display system and can work with telegraph equipment.

The methods of access and the devices which are supported by them (+) or not supported by them (-) and which are of interest from the viewpoint of simulation on the SM EVM are presented in general form in Table 1.

Table 1. YeS EVM Devices and Methods of Access that Support Them

(1) Методы доступа	(2) Локальные устройства		(3) Удаленные устройства					
	(4) ЕС7906	ЕС7920	(5) АП-2	АП-4	АП-61	АП-63	АП-70	ЕС7920
(6) ГМД	+	—	—	—	—	—	—	—
БТМД (7)	—	+	—	—	+	+	+	+
ОТМД (8)	+	+	+	+	+	+	+	+

Key:

1. Methods of access
2. Local devices
3. Remote devices
4. YeS
5. AP
6. Graphic method of access
7. Basic telecommunications method of access
8. General telecommunications method of access

Simulated devices of the YeS EVM. According to the program for development of hardware for the YeS EVM, 19 models of user stations having different characteristics and functional designation are now produced [7]. From the viewpoint of application in multimachine complexes, only seven of them, presented in Table 1, are of interest. However, effective use of multimachine complexes based on the YeS EVM and SM EVM cannot be achieved due to the presence of only

the corresponding methods of access. Soviet and foreign practice of introducing teleprocessing systems shows that the presence of user programs in them, based on one or another method of access, is a comparatively rare phenomenon. Program packs oriented toward organization of remote pack processing, dialogue mode and so on, are used to the maximum extent in these systems. In this sense consideration of such packs of the YeS operating system as DUVZ, OKA, KAMA and so on is of interest.

The relationship of program packs of the YeS operating system, most widely used to organize remote processing corresponding to methods of access and devices of the YeS EVM, is presented in Table 2. Here the YeS7920(L) and YeS7920(U) are local and remote versions of the YeS7920 complexes.

Table 2. Program Support of Some User Stations of the Unified Computer System

(1) Методы доступа	Пакеты ОС ЕС (2)				
	ДУВЗ	СРВ	КАМА	ОКА	КРОС
(3) ГМД	(7) ЕС7906		ЕС79.6	ЕС7906	
БТМД (4)	ЕС7920 (Л) ЕС7920 (У)		ЕС7920 (Л) ЕС7920 (У)	ЕС7920 (Л) ЕС7920 (У)	
(5) ОТМД		ЕС7906 ЕС7920 (Л) ЕС7920 (У)	ЕС7906 ЕС7920 (Л) ЕС7920 (У)		
(6) Физический уровень					АП-4

Key:

1. Methods of access
2. Packs of YeS operating system
3. Graphical method of access
4. Basic telecommunications method of access
5. General telecommunications method of access
6. Physical level
7. YeS

As follows from this table, the YeS7906 group control device with portable displays and the alphanumeric data display system in the local modification YeS7920(L) guarantee a direction with the same components of the YeS operating system and the YeS7906 device is supported by the GMD method for DUVZ and OKA packs, which operates only with its own graphical terminals, in addition to the YeS7906. If one takes into account in this case that the maximum number of displays in the YeS7906 is 16 and the maximum number in the YeS7920 is 32 and that the maximum rate of exchange of the YeS7906 with the channel is equal to 25 Kbytes/s, whereas this index is equal to 250 Kbytes/s for the YeS7920, it is obvious that further consideration of the YeS7906 device from the viewpoint of simulation of it makes no sense.

Thus, the given analysis of the methods of access that control program packs and that are supported by these components of the YeS operating system permits one to talk about the feasibility of simulating two devices of the YeS EVM: the AP-4 user station and the YES7920 alphanumeric data display system. Let us consider the characteristics and functions from the viewpoint of the earlier formulated requirements on multimachine complexes.

The AP-4 medium-speed user station (Figure 1) performs semiduplex exchange of data with the main computer according to the synchronous method of transmission. An unswitched telephone channel (A in Figure 1) is used for communications and the rate of exchange comprises 1,200 or 2,400 baud. Depending on the modification, the AP-4 unit may include a central device, ferrite core memory with capacity from 16 to 32 Kbytes, step magnetic tape storage unit, papertape input-output device, ATsPU [Alphanumeric printer], punch card input device and keyboard or display sequential printers.

The software and hardware for the AP-4 guarantee realization of the following basic functions:

--exchange of data with a remote computer in the pack or dialogue operating modes;

--data preparation on magnetic tape (up to eight users simultaneously);

--formation of pack from prepared messages for transmission to computer;

--integration of data preparation with computer exchange;

--buffering of received messages on magnetic tape;

--formatting and processing of received data according to algorithms used;

--data display to AP-4 users.

The YeS7920 alphanumeric data display system is produced in three modifications: a local group complex, remote group complex and remote single complex. The structure of each of them and their communication with the computer are shown in Figure 2. The remote single complex is not of interest from the viewpoint of simulation on the SM EVM and will not be considered henceforth.

A rate of exchange up to 250 Kbytes/s is guaranteed with local connection of the YeS7920(L) to the channel (K) of the YeS EVM. The YeS7920(U) complex exchanges data with the remote computer over unswitched telephone channels (A) by using the synchronous method of transmission at speeds of 600, 1,200, 2,400 or 4,800 baud.

The YeS7920 system includes a group control device (GUU), displays and printers. The total number of displays and printers connected to the group control device does not exceed 32.

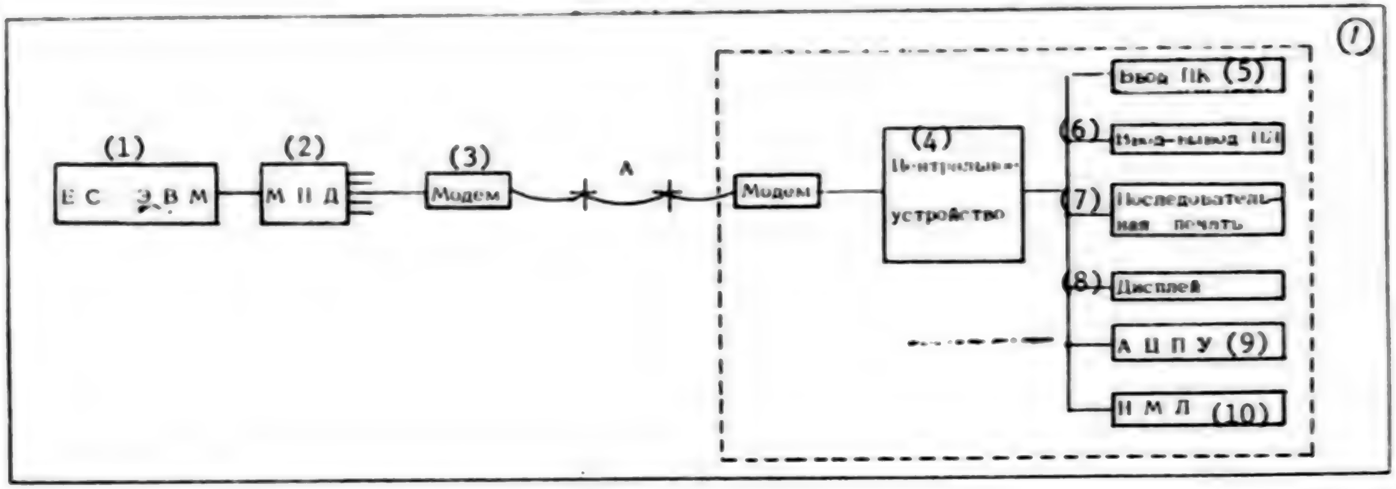


Figure 1. Composition of AP-4 User Station and Its Connection to YeS EVM

Key:

1. Unified Computer System
2. Data transmission multiplexers
3. Modem
4. Central device
5. Punch card input
6. Papertape input-output
7. Sequential printing
8. Display
9. Alphanumeric printer
10. Magnetic tape store

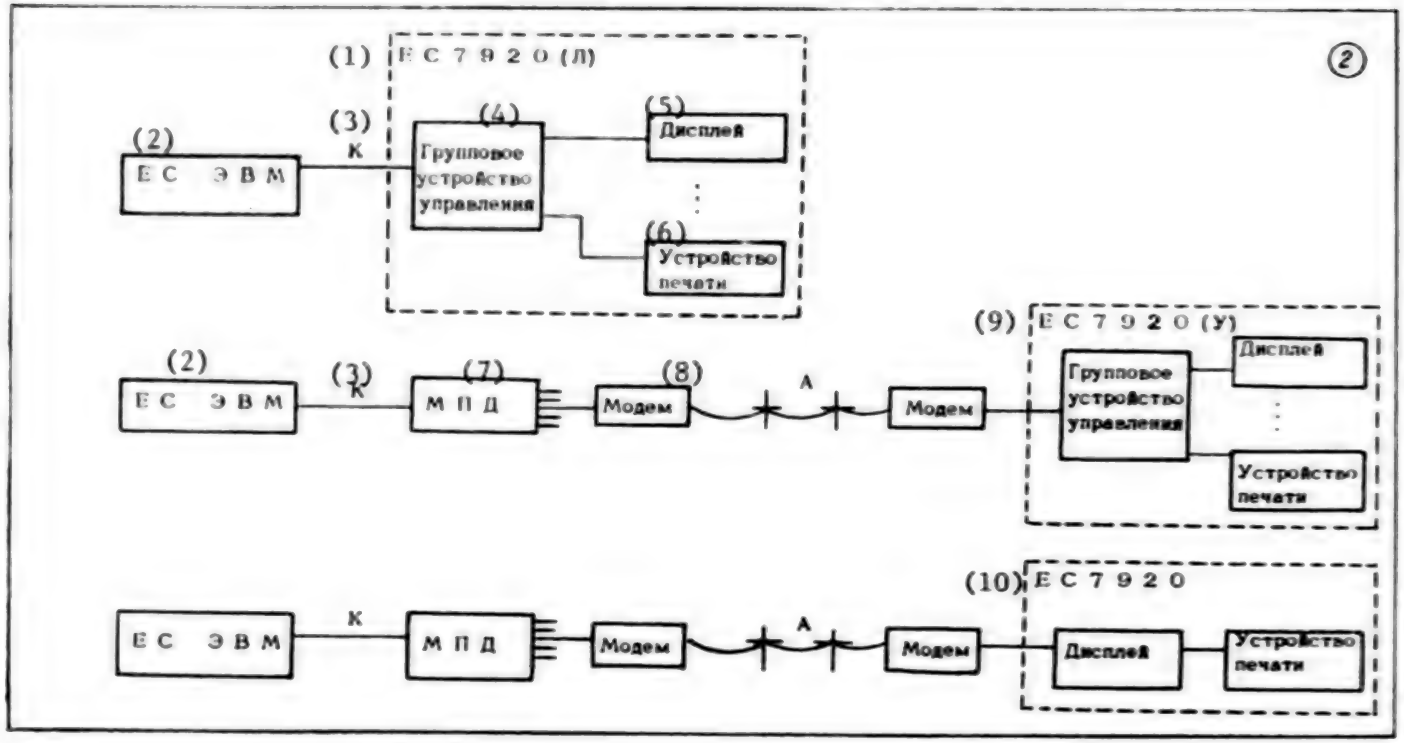


Figure 2. Structure of YeS7920 Complex: a--local group; b--remote group; c--remote single

Key:
1. YeS7920(L)
2. Unified Computer System
3. Channel
4. Group control device
5. Display
6. Printer
7. Data transmission multiplexer
8. Modem
9. YeS7920(U)
10. YeS7920

Both the local and remote YeS7920 complexes guarantee execution of the following functions:

--preparation and correction of data on the screen and simultaneously in the buffer memory of the display;

--transmission of the contents of the buffer memory of the display;

--data writing from the computer to the buffer memory and display of it on the display screen upon instructions from the computer;

--printing of the contents of the buffer memory to the printer when the functional key is pressed.

The given characteristics of the AP-4 and YeS7920 permit one to conclude that simulation of these devices on the International Small Computer System guarantees realization of the required functions of a multimachine complex since they accomplish remote and local entry and display of data, dialogue and pack modes of interaction with the YeS EVM, access to archives through the OKA and KAMA system and so on.

Let us now consider the hardware and software of the multimachine complex that include the SM EVM as simulators of the AP-4 and YeS7920.

Simulation of user stations of the YeS EVM on the SM EVM. The complexing hardware should guarantee the capability of organization of both local and remote interactions of the computers contained in the multimachine complex. From this viewpoint the computer integration device [8] for realization of local communications and the synchronous "SM common bus-standard junction S2" synchronous adapter for realization of remote communications are of greatest interest.

Considering complexing of the AP-4 and the YeS7920(U) complex, one may conclude that both devices should be simulated on the same hardware base of the SM EVM. This conclusion is determined by the following factors: both the AP-4 and the YeS7920(U) interact with the YeS EVM over unswitched telephone channels and both devices are group user stations of the YeS EVM.

Based on the foregoing, the hardware complex required to create a multimachin complex of the considered type can be represented in the form presented in Figure 3. It includes an SM-3P or SM-4P processor, systems console (Videoton 340 or VTA-2000 display), user displays, common bus and "SM common bus-synchronous junction S2" synchronous adapter.

The software of the complexes consists of basic and special software. As already noted, the basic software of the YeS EVM consists of the YeS operating system, program packs and the methods of access that support them. The multiprogram disk real-time operating system is used as the basic software of the SM EVM [8]. Special software of the SM EVM performs all functions of the simulated devices of the YeS EVM.

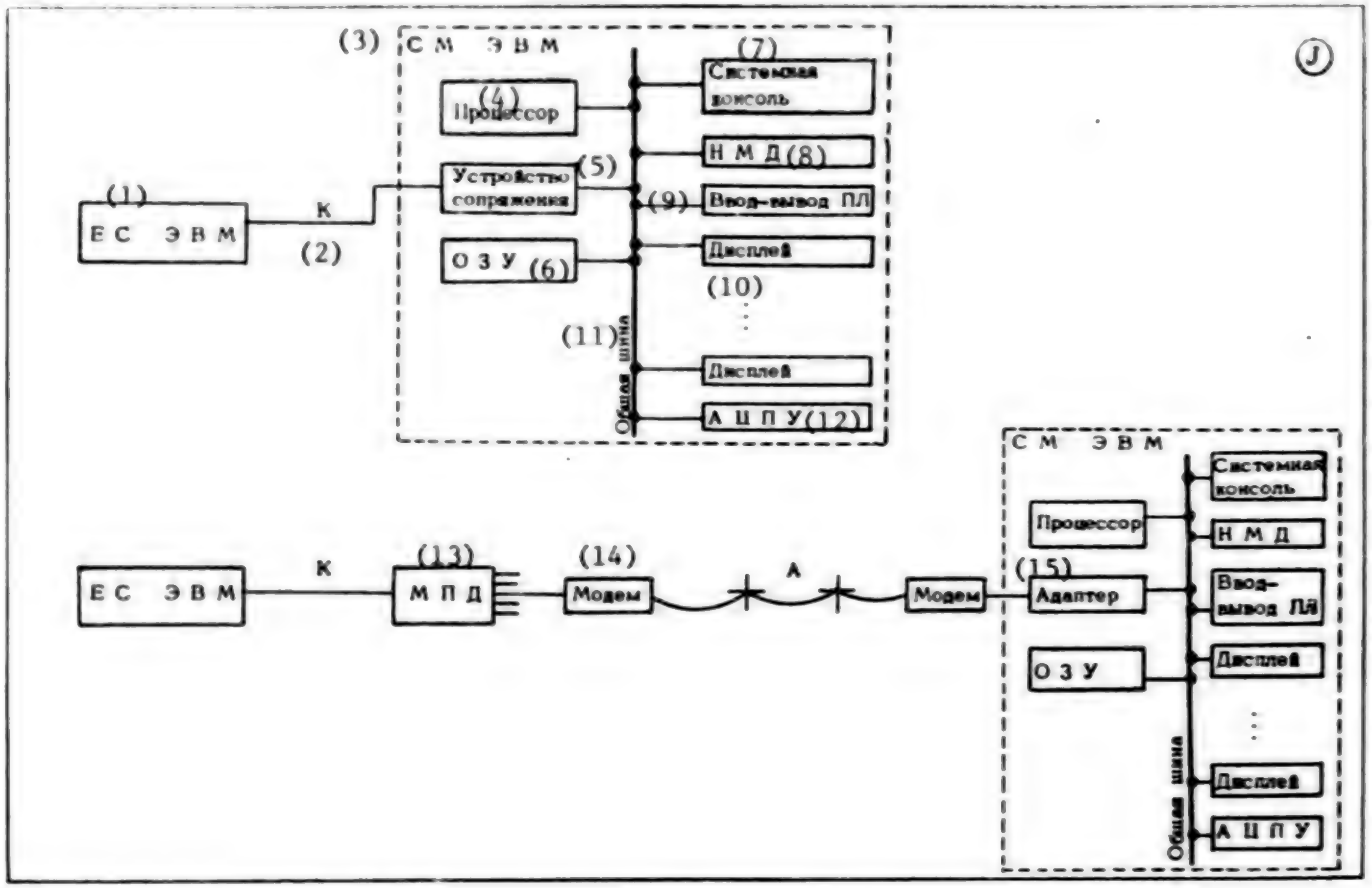


Figure 3. Structure of Simulator Hardware: a--of local YeS7920 complex; b--of remote YeS7920 complex and AP-4

Key:

1. Unified computer system
2. Channel
3. Internation Small Computer System
4. Processor
5. Integration device
6. Main memory
7. Systems console
8. Magnetic disk store
9. Papertape input-output
10. Display
11. Common bus
12. Alphanumeric printer
13. Data transmission multiplexer
14. Modem
15. Adapter

The structure and functions of the software for simulation of the local YeS7920 complex are determined to a significant degree by single addressing of the computer integration device from the direction of the YeS EVM channel and by the absence of service fields (user address, message length and so on) in messages formed for the computer integration device by programs that realize the corresponding methods of access. The combination of these factors results in the fact that information received from the YeS EVM cannot be compared to a specific user upon realization of the group device in the SM EVM if interrogations were transmitted from several of them to the main computer.

The given dircumstance determined the need to develop two modifications of the YeS7920(L) simulator--a single-channel and multipchanel, the software structure of which is shown in Figure 3 and in the inside back cover. Here P_i and R_j are user programs of the YeS operating system and the real-time operating system, respectively, Q_1 is the control program (pack) of the YeS operating system, for example, DUVZ, Q_2 is programs that realize the method of access (BTMD or OTMD), Q_3 is the driver program of the computer integration device, Q_4 is the auxiliary control processor of the real-time operating system that guarantees operational simulation of the GUU and the displays and Q_5 is "Pack instruction interpreter of the YeS operating system" control program.

Interaction of the software components of the multimachine complex is accomplished by using the following interfaces: I_1 is a means of interaction of the user programs with the control pack of the YeS operating system (Q_3), I_2 is macroinstructions of the method of access and I_3 is macroinstructions of intermachine interaction.

The single-channel simulator of the YeS7920 functions according to the following rules:

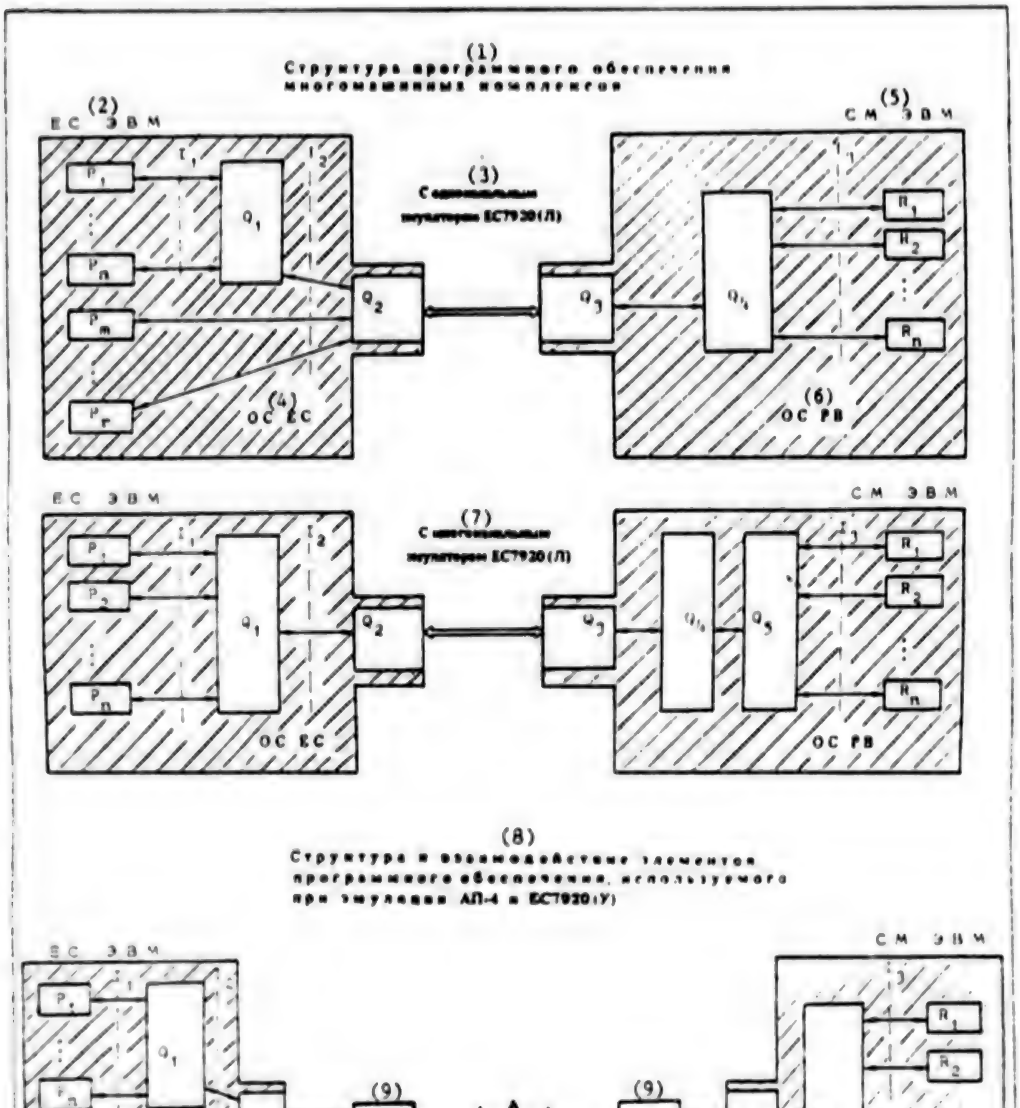
--any dialogue cycle between the pack Q_1 ot program P_i and program R_j is always initiated by the user program in the SM EVM;

--program channel Q_4-Q_3-Q_2 is a sequentially used resource and the channel is attached to it when any of the programs R_j is opened and is inaccessible to other user programs in the SM EVM before it is released or until completion of R_j;

--circuit Q_3-Q_4 realizes its own simulation of instructions of the YeS7920 (L) device, providing a transparent exchange mode when working with any components of the YeS operating system that utilize the Q_2 method of access.

The basis for functioning of the multichannel simulator of the YeS7920(L) is the fact that the information transmitted to the YeS EVM contains both data for programs P_1-P_n and instructions addressed to pack Q_1. This sharing permits one to guarantee simultaneous interaction of several programs in the SM EVM with programs executed in the YeS EVM under the control of pack Q_1. Let us consider the functioning of a multichannel simulator in a multimachine complex where DUVZ is used as Q_1 in the YeS EVM.

As in the preceding case, when using a multichannel simulator, any dialogue cycle between program R_j and pack Q_1 or program P_i is initiated from the SM EVM.



[Key on following page]:

Key:

1. Structure of software for multimachine complexes
2. Unified Computer System
3. With single-channel simulator of YeS7920(L)
4. YeS operating system
5. International small computer system
6. Real-time operating system
7. With multichannel simulator of YeS7920(L)
8. Structure and interation of software components used in simulation of AP-4 and YES7920(U)
9. Data transmission device

However, several user programs in a multichannel structure can simultaneously open the logic channel for communicating with the corresponding software component of the YeS EVM. The information transmitted from programs R_j, as already noted, contains instructions addressed to the DUVZ and/or data itself.

The instruction interpreter of the DUVZ pack (Q_5) follows the transmitted instructions and if it detects an instruction that is a request for data exchange (for example, OUTPUT, EDIT and so on), it interlocks circuit Q_4-Q_3-Q_2 for the duration of this exchange. After reception-transmission of data, the indicated circuit is freed for work of other programs of the SM EVM. In this case information instructions and file transmission instructions can be distinguished among those addressed by the DUVZ. The first group includes requests to receive information about the status of files, programs and so on from the YeS EVM. The answers coming in to them are small in volume and are immediately transmitted to the corresponding program R_j. These instructions are processed the same as in a single-channel simulator.

File transmission instructions result in exchange of entire files between different computers of the multimachine complex. In this case circuit Q_4-Q_3-Q_2 is interlocked only for the duration of file transmission from the disk of the SM EVM to the YeS EVM or for the duration of file reception from the YeS EVM and buffering of it on the disk of the SM EVM. Since program R_j that transmitted the corresponding instruction to the YeS EVM is known in this case, the buffered file is assumed to belong to it. All subsequent instructions for receipt of information from this file, issued by R_j, summon reading of the following recordings from the disk and transmission of them to the program. A similar situation in a single-channel system results in constant exchange of data between the YeS EVM and SM EVM.

The AP-4 and YeS7920(U) complex are simulated with regard to the fact that the corresponding protocols are realized when working with BTMD and OTMD communications lines, i.e., they work with the address fields of messages and thus solve the problem of addressing several programs executed in the SM EVM and interacting with programs in the YeS EVM. Therefore, only multichannel systems are considered in developing simulators for these devices.

The software structure of the corresponding multimachine complex is shown on page 3 of the inside back cover. Here Q_4 is the auxiliary control processor that keeps a record of interaction according to the algorithms of the main

method of synchronous data transmission in KOI-7, synchronizer 1 (for the AP-4) or synchronizer 3 (for the YeS7920) and APD is the communications equipment of the YeS EVM and SM EVM.

Data is exchanged in this system according to the indicated record sheet of interaction and according to the use of the same standard interfaces I_1-I_3 as in other simulators. In the given case control program Q_4, besides keeping the record sheet and formatting the messages, performs supplementary functions that simulate operation of the group control device, guaranteeing transmission of information to the corresponding user programs R_1-R_n.

Let us consider to what extent and how the described simulators perform the functions of the corresponding devices of the YeS EVM.

Data exchange with remote and local computers, as was shown, is guaranteed by the set of programs Q_3 and Q_4 and in the multichannel simulator of the YeS7920(L) is guaranteed by control program Q_5.

The data are prepared (stored and edited) by standard equipment of the real-time operating system--exchange program between the carriers (PIP) and symbol editor (EDI).

The message pack for transmission to the YeS EVM is formed by the exchange program between carriers (PIP), which combines the messages into a single pack on a magnetic disk, and also by the program for reading the pack from the disk and transmission of it through interface I_3 to program Q_4, which forms the pack according to the record sheet used and which transmits it to the communications line.

As already indicated, messages received from the YeS EVM are buffered by program Q_4.

Formatting and processing of data received from the YeS EVM are accomplished by development of the corresponding programs that carry out processing according to the reuqired algorithms.

Data is displayed to users both by standard equipment of the real-time operating system (PIP) and by special terminal programs R_1-R_n that use macroinstructions of the interface and standard macroinstructions for exchange with terminals.

Macroinstructions for intermachine interaction. In conclusion let us consider the macroinstructions for intermachine interaction that realize interface I_3.

Six macroinstructions--open logic channel (NOC¤), closed logic channel (NCL¤), read message (NRD¤), declare subroutine for processing interrupt for receipt of message from YeS EVM (NAT¤), stop started operation (NKL¤) and write message (NWR¤)--are included in any of the considered macroinstruction systems of intermachine interaction.

Creation (destruction) of tables that characterize user programs as users of the multimachine complex is guaranteed by macroinstructions NOC¤ and NCL¤. The logic

channel for a single-channel simulator is the only one, while the number of logic channels open simulatneously is limited by the capacity of the main memory, allocated for the special software of the SM EVM, for a multichannel simulator.

Macroinstructions NRD¤ and NWR¤ guarantee exchange of information of the corresponding program R_j with the program in the YeS EVM. When the read operation is executed, the program receives the information buffered on the disk or the fact of issue of the macroinstruction is noted in its logic channel and it receives information immediately after the corresponding message comes in from the YeS EVM.

When using macroinstruction NAT¤, program R_j declares the address of the input point to which control will be transferred upon arrival of the message for this program. This mechanism of processing asynchronous interrupts guarantees the capability of combining data exchange and processing operations in user programs in the SM EVM.

Processing of all exchange operations started earlier by the program is stopped by macroinstruction NKL¤ and the corresponding logic channel is closed.

The considered hardware and software structures of heterogeneous multimachine complexes guarantee the capability of using the SM EVM as multiuser stations for the YeS EVM. The single program interface I_3, used in the special software of the SM EVM, guarantees execution of user programs R_1-R_n in any of the simulators without any modifications whatever.

The capability of the simulators working with new packs of the YeS EVM, including those based on the virtual telecommunications method of access, is guaranteed due to variation of those software components of the multimachine complex as Q_3 and Q_4. No modifications of user programs in the SM EVM of any kind are required.

The special software realized on the basis of the real-time operating system performs all functions of the simulated devices and a number of additional functions that increase the efficiency of using the user station.

The considered software of the multimachine complex was tested on the YeS1060 and SM-4, connected by a computer simulation device, at the internation exhibition "Equipment of the Unified Computer System and the International Small Computer System and their application." The YeS7906 group device was simulated on the SM-4 in this multimachine complex.

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6521
CSO: 1863/214

STRUCTURES AND CAPABILITIES OF BIT-SLICE EXPERIMENTAL SYSTEM

East Berlin RADIO FERNSEHEN ELEKTRONIK in German
Vol 31, No 5, May 82 pp 280-283

[Article by Rainer Sandau and Eckehard Lorenz, Institute for Cosmic Research at the Academy of Sciences in the GDR]

[Text] The switching circuits for series K589 (USSR) and MH 3000 (CSSR) make available switching circuits by means of which it is possible to build up bit-slice microprocessor systems. The architecture and instruction inventory of these systems can be tailored to the problem solution. However, the effort to design the microprogram for bit-slice systems is greater than with microprocessor systems that have a fixed instruction set. This paper presents an experimental system by means of which microprograms, which were written for the implemented structure, can be tested.

Available MOS microprocessor systems work with a fixed instruction set and a fixed word length. For various applications, these do not provide the required working speed. In many such cases, microprogrammable bit-slice systems can provide a remedy. Their architecture, instruction set, and word length can be specified in accord with requirements.

The flexibility in the design of bit-slice microprocessor systems, with their problem oriented structure, is opposed by two disadvantages:

The development of bit-slice systems requires more hardware and software, compared to microprocessor systems that are based on microprocessors with a fixed instruction set. The bit-slice elements must be supplemented with a microprogram control and additional marginal electronics, so as to form functional systems. Furthermore, the microprograms, with their problem-oriented structure, must be programmed and tested, taking into account the selected hardware structure.

Because of the many degrees of freedom in the system design, there scarcely exist any development systems for the corresponding families of switching circuits.

The bit-slice experimental system TR 589 is presented below. This system is built up with the family of switching circuits K 589 (USSR). The TR 589 implements a typical 16-bit computer structure and is suitable to develop and test microprogrammed machine instructions and machine instruction sets, inasmuch as these are compatible with the given basic structure. The families K 589 (USSR) and MH 3000 (CSSR) are representatives of the Schottky-TTL technology. The most important ICs for building up a bit-slice system are summarized in the table. The functions of these switching circuits are described in references [1] and [2], and will be discussed in this paper only to the extent required for understanding the overall function.

The switching circuits of the series K 589 and MH 3000

Type	USSR		CSSR
Microprogram control unit (MCU)	K 589	01	MH 3001
Process element (CPE)	K 589	02	MH 3002
Fast transmission generator (CLG)	K 589	03	MH 3003
8-bit buffer	K 589	12	MH 3212
Interrupt control unit (ICU)	K 589	14	MH 3214
Bidirectional bus driver	K 589	16	MH 3216
Bidirectional bus driver, inverting	K 589	26	MH 3226

Structure of the TR 589

Figure 1 shows the hardware structure of the bit-slice system TR 589. This hardware consists of the following:

Central unit with 16 bit processing and addressing width, microprogram control and interrupt control unit

Two microprogram memories MPS 1 and MPS 2, which can be switched in optionally, and each of which has 512 microinstruction words with 40 bits each

A control section to generate the signals for the control bus of the system; here, this circuit also generates the signals for system start (RES) and for testing the machine programs in machine instruction steps (MAS) and the machine instructions in microinstruction steps (MIS).

A control keyboard for direct storage access (DMA) and for setting the interrupt points.

Peripheral data equipment, consisting of a cassette tape unit (KMBG), a paper tape reader (LBL), a paper tape punch (LBS), a telex (FS), a display screen (BSG), and an alphanumeric keyboard. This equipment is controlled through the associated interface complex.

A multichannel indication of the logic level, so that during machine instruction cycles or microinstruction cycles, all signals of interest (data bus, address bus, control bus...) can be traced.

EPROM for 12 Kwords with 16 bits each

RAM for 8 Kwords with 16 bits each

The hardware was eqipped with a microprogram which implements the instruction set proposed in reference [3]. This instruction set is stored in one half of the microprogram memory MPS 1. To expand the instruction set or to implement a completely independent instruction set, one can use the second half of the MPS 1 and the entire MPS 2.

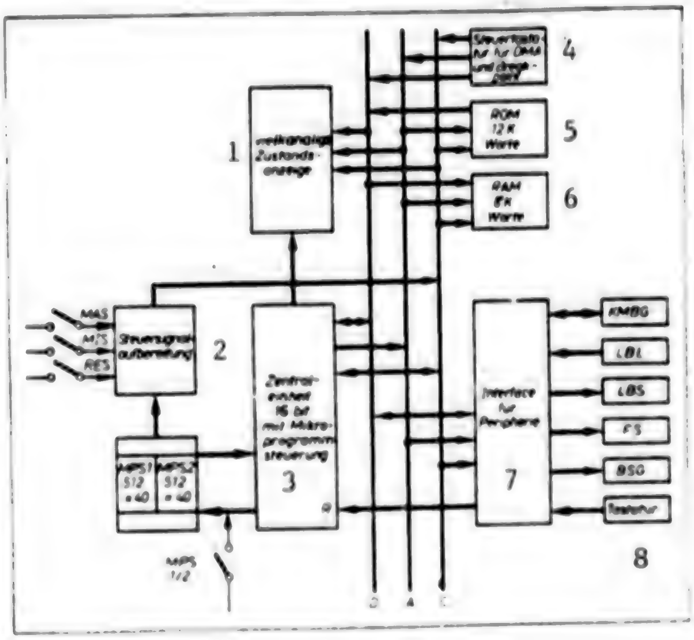

Figure 1: Hardware of the TR 589

1 multichannel status indicator
2 control-signal processing
3 central unit, 16 bits, with microprogram control
4 control keyboard for DMA and break point
5 ROM 12 Kwords
6 RAM 8 Kwords
7 interface for peripheral equipment
8 keyboard

An operating system was developed on the basis of the instruction set, where this operating system manipulates data in the memory (e.g. program revision) and works with the peripheral data equipment, via a command or command sequences. The operating system requires about 4 Kwords of the ROM region.

The TR 589 can optionally be controlled through the microprogram memories MPS 1 and MPS 2, and this affords the possibility, when the MPS 1 is activated, of loading the RAM with a program that has been written for the second instruction set stor in the MPS 2. Subsequently, after transferring control to the MPS 2, the machine programs or the microprograms can be tested.

Hardware

The hardware core of the TR 589 consists of the central unit (ZE), the microprogram memory (MPS), the control signal processing unit, the DMA channel, and the memory (RAM, ROM). It was generated as an application of the universally applicable hardware structure that has been described in reference [4]. The components belonging to this hardware core consequently will be described only to the extent necessary for the system application.

The multi-channel indicator circuits makes it possible to observe all interesting individual signals and information buses in single-step operation (in microinstruction steps and in machine instruction steps). It is therefore an important aid for testing the microprograms and also the machine programs. Its technical implementation will not be discussed in this paper; it has been described in detail in reference [5].

Central Unit

Figure 2 shows the basic circuit diagram of the central unit ZE. The ZE contains the CPE field, the interrupt control unit ICU, the microprogram control unit MCU, a pipeline register, and a bus driver for the address bus and the data bus.

CPE Field

The CPE Field is designed with eight bit-slice switching circuits for a processing and addressing length of 16 bits. The M- and D-buses are wired together to form a bidirectional data bus. The I-bus is connected with the D-bus interchanged bytewise, so that byte exchange operations can be performed. The K-bus (mask bus) of the CPE field is wired together group-wise according to Figure 3 , so that word and byte processing are possible through four bits which are presented in groups and additionally access to the highest-value bits of the bytes is also possible. The CPE field can be timed through the control bus separately from the other control units.

Interrupt Control

Interrupt acceptance is implemented in the proper priority by means of the ICU. The buses A and B of the ICU are connected with the lowest-value bits of the bidirectional data bus, to identify the reported interrupt level and to write in the current priority level. Through the control signal processing unit, the device address zero is permanently assigned to the ICU.

Microprogram Control

The X-bus of the MCU is connected with the high-value byte of the data bus. The machine instruction coded in this byte determines the starting address for the required microprogram sequence.

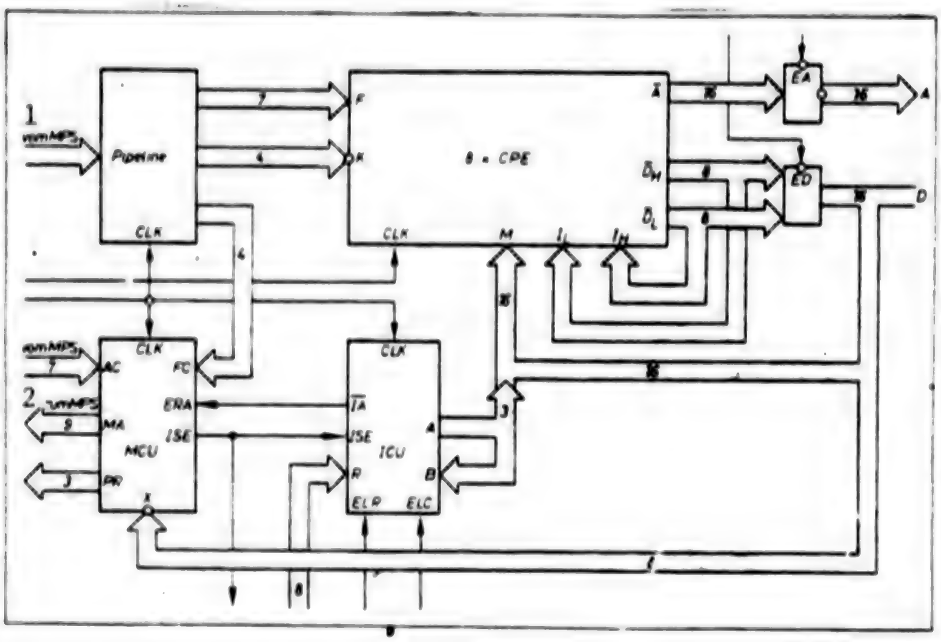

Figure 2: Block diagram of the central unit

1 from the MPS
2 to the MPS

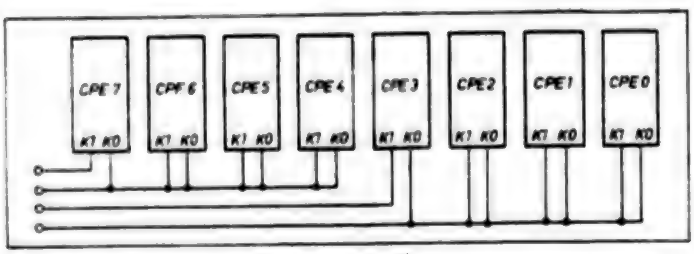

Figure 3: Summary of the K-bus by groups

Pipeline Register

The pipeline register makes it possible to, during the same time that the current microinstruction is being processed, already read the next following microinstruction from the MPS. In this fashion, it is guaranteed that a microinstruction can be processed in each cycle.

Microprogram Memory

The MPS consists of two identically structured storage sections, each with a capacity of 512 microprogram words, at 40 bits each. Which of the two MPSs is activated depends on the switch position MPS 1/2.

Figure 4 shows the structure of the microprogram word. When implementing further instructions, 15 bits of the microprogram word can still be used in a manner specific to the problem.

Control-Signal Processing

The control-signal processing unit guarantees the normal, undisturbed, program processing, as well as program processing in machine instruction steps and in micro-instruction steps. For example, through the C-bus (three bits of the microprogram word), work with the memories (read, write) and with the peripheral units (input, output), as well as the conditional suppression of the CPE cycle, is organized.

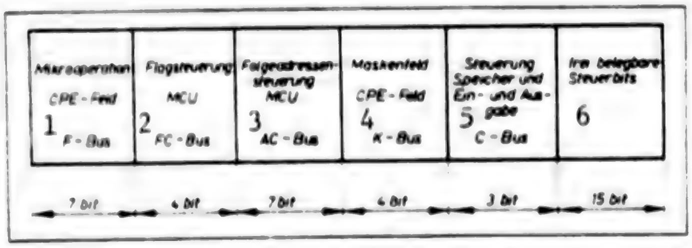

Figure 4: Format of a microinstruction

1 microoperation CPE field F bus
2 flag control MCU FC bus
3 consequential address control MCU AC bus
4 mask field CPE-field bus
5 control, storage, and input/output C bus
6 freely allocatable control bits

Step Operation

Step operation is set with the switches MAS (stop after machine instruction) and MIS (stop after microinstruction). Step operation, in conjunction with the multi-channel status indicator is a valuable aid for testing the micro- and machine-programs. The interesting individual signals and information buses can thus be traced in step operation.

Control Keyboard

The control keyboard is provided for DMA operation and for setting the interrupt points. In DMA operation, it is possible to control the memory contents through the multi-channel status indicator.

The interrupt-point circuit operates in such a fashion that, beginning at a prescribed starting address, the number of system cycles is measured until a prescribed interrupt address is reached. When the interrupt address is reached, a signal is emitted which can be utilized as an interrupt signal or as a stop signal. The number of measured cycles can be read on the multi-channel status indicator.

Memory

The TR 589 is equipped with EPROMs for 12 Kwords and with one 8 Kword RAM region. If necessary, the RAM and ROM regions within an address region of 32 Kwords can be distributed on arbitrary 4 Kword-long pages.

Peripheral Data Equipment

A device technology that is simple but that is adequate for microcomputer systems was selected for the peripheral data equipment. It consists of an alphanumeric keyboard, a television unit as a display screen unit, a telex, a commercial cassette tape unit and a paper tape station.

Short Description of the Software

The software for this system consists of the microprogram that implements the machine instructions and of an operating system which makes it possible to generate and test programs, and to input, store, and output data and programs through a command system.

Machine Instruction Code

The microprogram implements the instruction code in reference [3]. This instruction code contains among many other things:

Memory related instructions for implementing arithmetic and logical operations as well as instructions for loading registers and memories (including stack operations) in the following addressing modes: direct, indirect, indirect relative, indirect index, indirect index relative. Part of the instructions is also possible with direct operands.

Instructions for register exchange

Twelve conditional transfers and one unconditional transfer in the addressing modes relative and indirect

instructions for implementing the subprogram technology
shift instructions
byte instructions
I/O instructions

Operating System

Upon system start, which has been triggered by the RESET signal, the microprogram initializes the ZE. It is thus possible to make a definite entry into the monitor program, which makes possible conversational mode operation by means of keyboard input and display screen and/or telex output. By means of two library lists - one for the programs stored in the ROM and one for the program sequence which has been inputted in symbolic form is controlled. The processing of data and instruction sequences that have been inputted to machine code is likewise possible. Error messages essentially exclude operating errors. After the prescribed program or instruction sequences have bee processed, the monitor program again goes into its basic state and expects further commands.

The possibility of using separate program and data base registers permits the simple linkage of various conversion systems; an expansion of the already feasible modes of representing the information is thus possible without changing the monitor program. The monitor system can fall back on the following program complexes:

Conversational mode system which can process various text and data
Conversion system, which currently implements conversion of octal, hexadecimal, and integer representations into binary form and vice versa. Furthermore, this system contains routines for processing character chains which are used in the monitor.
Program for organizing the display screen display
Program complex to control the receiving complex
Programs to interpret the keyboard functions
Programs to control the paper tape station
Programs to control the cassette tape unit
Program to organize the RAM library list with symbolic nomenclature.

A program that is important for program testing is the interrupt-point routine by means of which, when the interrupt point has been reached, the status of the ZE (register contents) as well as the next instruction to be processed can be indicated. All the information indicated can be changed, and the computer continues its work with the altered status that has been generated in this way. A special interrupt-point circuit, in conjunction with this routine, permits step-by-step processing of programs with a clear acknowledgement of the results after executing the respectively current machine instruction.

Programs which work with the instruction code stored in MPS 2 can likewise be tested if, at the end of the instruction, an automatic switchover to MPS 1 takes place. However, in this operating mode, there are restrictions which depend on the structure of the second instruction code.

Summary

The bit-slice experimental system TR 589, which has been presented here, can be used as an autonomous microcomputer. Its operation as a microcomputer can be supported by the peripheral data equipment that is connected to it and by the operating system. Furthermore, it is possible to expand the existing instruction code within the framework of the available 256 microprogram words of the MPS 1, or to store a completely different instruction code in the MPS 2 (512 microinstruction words). For problem-specific controls, 15 bits of the microprogram word are then still available. One of the two microprogrammer memories is selected with a switchover circuit. Thus, for example, it is possible, by means of the operating system or the EMA circuit, to load programs into the RAM region, which have been provided with the second instruction code for their processing. After switching over to the MPS 2, the programs can then be tested in the microinstruction steps or in machine instruction steps. Individual signals and information buses that may be of interest here can then be traced by means of the multi-channel status indicator. The programs can be changed by means of the DMA circuit or, after switching over to MPS 1, by means of the operating system.

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8348
CSO: 1851/3

YeS-1045 DELIVERED AHEAD OF SCHEDULE

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 20 Jul 82 p 1

[Article by R. Gareyev, Chairman of Plant Trade-Union Committee of Kazan' Computer Plant: "Support for the Brigade]

[Excerpts] There are now hundreds of right-flight competitions at the Kazan' Computer Plant in honor of the 60th anniversary of the USSR that have considerably overfulfilled the personal tasks. A large part of them now work in brigades. This has permitted the plant collective as a whole to overfulfill the plan in volume of production during six months.

The success of the plant brigades is specifically expressed in ahead of schedule and high-quality fulfillment of the orders for delivery of modern coputer equipment. Thus, workers of the Administration of Northwestern Trunk Oil Pipelines received the YeS-1045 computer from Kazan' one quarter ahead of schedule. This same computer was delivered three months early to the Administratio of Production and Preventive Maintenance and makeup of equipment of the Tatneft' Association [Tatar Petroleum Association] and a number of other organizations.

6521

CSO: 1863/339

COOPERATIVE DESIGN OF SM 50/40

Kiev PRAVDA UKRAINY in Russian 31 Jul 82 p 3

[Article by Igor' Gorkun, special correspondent of PRAVDA UKRAINY]

[Excerpt] The two computer equipment systems operating within CEMA are now oreinted toward the use of microprocessors. I have in mind the unified system of large computers (YeS EVM) and the system of computers of "mini" class (SM EVM). The first swallow in this matter was the SM 50/40 computer designed by specialists of the Peoples Republic of Bulgaria, the Hungarian Peoples Republic, the Socialist Republic of Rumania, the USSR and the CSSR.

Like other representatives of the unified families of computers, the SM 50/40 computer is produced by a coordinated production program on the basis of international division of labor. For example, one can see in it magnetic disks manufactured by the Bulgarian Association Izot, printers made by workers of the GDR Peoples Enterprise Robotron and displays of the Hungarian firm Videoton. Microprocessors and also devices for communicating with control entities are produced by Soviet enterprises.

The workers, engineers and scientists of the fraternal countries are now participating in working out a cooperative program for 1982-1990 on development and extensive use of microprocessor equipment in the national economy of the countries included in CEMA. Production of a wide nomenclature of automatic equipment, machines, devices and control systems for machine building, power engineering, metallurgy, agriculture and transport will be assimilated as a result of implementation of this program.

Statistics are Indicative

Microprocessor devices are now being developed at unprecedented high rates. Whereas four generations of computers were produced during 30 years of the "start in life," the member countries of CEMA have not reached their fourth generation during 10 years since microprocessors appeared. This is the result of the presence of an enormous number of timely applications which microprocessors and microcomputers can provide.

Microprocessors can find application in more than 200,000 different types of devices and installations of industrial and service significance, which in itself is a technical revolution.

The system of management of the integration process in the socialist community should be applied so that an operational and effective answer can be given to the timely questions posed by life in the interests of all participating countries. The work of the headquarters of CEMA--its secretariat--is primarily directed toward this. As you, the reader, have already managed to note, a large international collective of representatives of all states included in the community is laboring here. It is they, the workers of the secretariat and representatives of all the fraternal countries who manage a large and important affair together and who actively affect the implementation of plans and agreements into real plans in which the continuous aspiration of the peoples of the socialist world to strengthen friendship and to widen cooperation are invited.

The need for collective discussion in the near future of such problems as bringing the structures of economic mechanisms closer together, development of direct contacts between ministries, associations and enterprises participating in cooperation and creation of joint firms was emphasized at the 26th CPSU Congress. As indicated in the decree of the CPSU Central Committee "On the 60th anniversary of the Union of Soviet Socialists Republics," "life itself posed the problem of supplementing the soordination of plans by coordination of economic policy as a whole to the fraternal countries." We are now observing this process. The world of socialism continues its historial rise.

6521
CSO: 1863/339

UDC 681.327.2

LASER COMPUTER INFORMATION RETRIEVAL DEVICE IN FORM OF TOPOGRAPHIC FORMATS

Novosibirsk AVTOMETRIYA in Russian No 2, Mar-Apr 82 (manuscript received 24 Jun 80) pp 3-6

[Excerpts from article by V. P. Bessmel'tsev, I. S. Degtyarev, V. P. Koronkevich, V. D. Kosterin, G. I. Murzin and Yu. N. Tkachuk, Moscow, Novosibirsk]

[Excerpts] Fast production of a large number of copies of images synthesized or processed in a computer is required in many cases, for example, such as processing aerial and space information in a computer. Devices are known [1-4] that permit retrieval of the information file in half-tone form onto photographic film. However, the real speed of these devices is limited by the process of developing the film, which is their serious disadvantage. A device that permits retrieval of half-tone and alphanumeric information onto a solid carrier without developing has been created at the Institute of Automation and Electrometry, Siberian Department, USSR Academy of Sciences, jointly with the Moscow Polygraphic Institute. The device can manufacture a typographic format with subsequent production of up to 10,000 prints from this format on ordinary topogrpahic printing machines.

Experimental results. An LG-25B current-stabilized infrared laser was used as the emission source in the laser computer inforamtion retrieval device. The output of the laser varied in the range of 10-40 W as a function of the material being used and the method of printing. The intensity of the recording emission was varied by an electro-optical modulator fo type ML-8 with forced cooling.

Transparent lavsan film 100-300 μm thick was used to produce the offset prints. A heat-sensitive coating was applied to the film for direct visualization of the retrieved information.

Commercial transparent sheet celluloid 300-800 μm thick was used as the material for high-print formats. The working side was covered with a thin layer of dye.

The photoformats for the offset print, produced when processing the same image on a computer, are presented in Figure 4. The half-tone regions included in the outline of the main image were determined by program. The size of the raster element was 200 μm in this case.

The test results showed the following technical specifications of the device: the size of the quantification increment of the image of 50 ± 2 μm, recording speed (depending on the method of printing) of 0.6 (0.3) m/s, size of the raster structure for the printed formats of 200 X 200 μm for offset printing and 50 X 50 μm for high-contrast printing, number of transmitted gradations > 16 and number of copies from the matrix manufactured by the device 10,000.

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CSO: 1863/190

UDC 621.382.8;681.327(088.8)

PHOTOMATRIX ASSOCIATIVE MEMORY

Novosibirsk AVTOMETRIYA in Russian No 2, Mar-Apr 82 (manuscript received 18 Feb 81) pp 13-19

[Article by S. F. Kibirev, S. I. Konyayev and S. I. Naymark, Novosibirsk]

[Text] The most realistic method of creating a relatively inexpensive large-capacity memory (10^8-10^{10} bits) with associative access properties is related to the use of a semiconductor buffer memory in the address memory [1]. This associative memory has been named a two-level or block-oriented memory. Specifically, a two-level associative memory can be developed on the basis of a magnetic disk and MDP [magnetic disk semiconductor] integrated associative memory [2]. Retrieval operations are performed in this case by the series-parallel method by recording and writing individual parts of the data file in the associative buffer. The indicated method has a significant limitation: a large fraction of time is expended on the operation of series recording of data in the associative memory (AZU). In this regard an advantage in speed is achieved only when solving complex associative data processing problems.

The operation of sequential recording of data is eliminated in the "page-organized holographic memory--optoelectronic AZU" structure (the latter is a semiconductor associative memory with optical input). Data is recorded in this case in parallel to all cells of the optoelectronic AZU by projection of the pages of data from the holographic memory onto the photosensitive inputs. High speed of data retrieval from the page-organized holographic memory (1,000 Mbit/s) with parallel recording and processing of pages of data in the opto-electronic AZU is combined in the considered structure of the two-level associative memory. This determines the potentially high productivity of the structure as a whole.

The main distinguishing feature of the optoelectronic associative memory is the design of the associative memory, which is a homogeneous matrix of L X N associative cells integrated with the corresponding photodetector array. We named this memory a photomatrix associative memory (FMAN).

The given work is devoted to problems of developing a photomatrix associative memory in the form of an optoelectronic BIS [large integrated circuit], the photodetector part of which meets the requirements of a permanent holographic memory by its geometric and optoelectronic parameters [3]. The structure of

an optoelectronic associative memory containing a photomatrix associative memory, the design and circuitry of the photomatrix associative memory made by MDP-integrated technology, and the results of functional tests and measurement of the optoelectronic parameters of experimental models of the photomatrix associative memory are considered in the work.

Photomatrix associative memory in structure of optoelectronic associative memory. The digital information files in the page-organized hologram memory are represented in the form of a sequence of holograms, in each of which a page of data K, consisting of L N-digit binary words ($k_{l1} \ldots k_{ln} \ldots k_{lN}$) ($l = \overline{1, L}$), is recorded. These words are the data file or set of features projected onto the photosensitive surface of the photomatrix associative memory in the form of dark and light spots upon restoration, depending on the type of processing.

The optoelectronic memory has a traditional structure in general features [4], shown in Figure 1, a: 1--a photomatrix associative memory, which is a matrix of memory cells, each of which contains an optical input and associatve processing circuit; 2--a L-digit address register; 3--a N-digit output register; 4--a N-digit retrieval independent variable register Z; 5--a N-digit mask register M; 6--a L-digit coincidence display with adjustable input logic; and 7--a control unit.

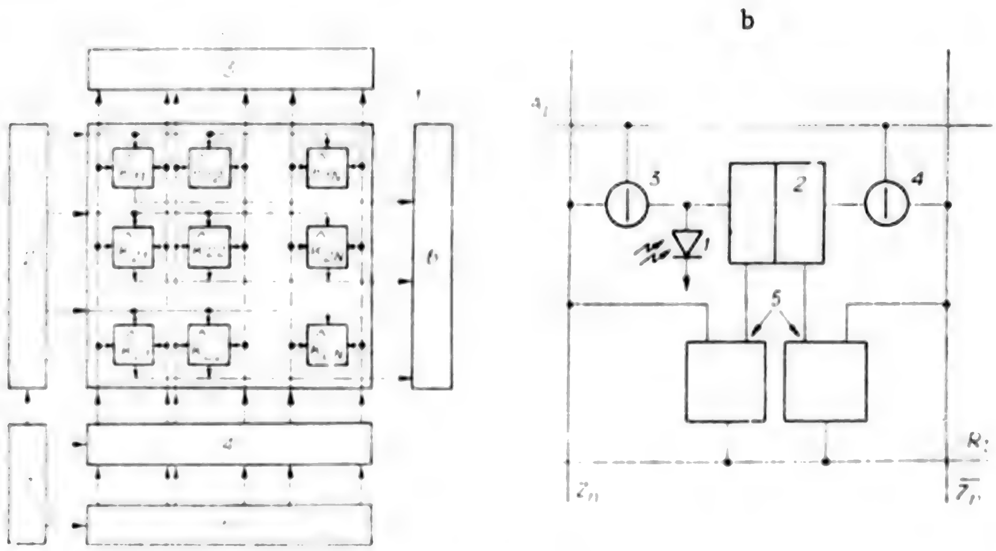


Figure 1.

The basic function of associative processing is the vector-function $R = \{r_l\}$, realized in parallel within the page $K = \{k_{ln}\}$ and determined by the equality

$$r_l = \sum_{n \in \{M_n = 0\}} (k_{ln} Z_n + \bar{k}_{ln} \bar{Z}_n) \quad (1)$$

or

$$r_l = \sum_{n \in \{M_n = 0\}} (k_{ln} \bar{Z}_n + \bar{k}_{ln} Z_n), \quad (2)$$

where Z_n is an n-digit binary code of the retrieval independent variable and k_{ln} is an n-digit binary word with number 1 written in the photomatrix associative memory. Summation is carried out for all unmasked digits, for which $M_n \neq 0$.

Since Z_n and k_{ln} can assume values of "0" or "1," one can determine summation in (1) and (2) in two ways. If summation is carried out in the ordinary sense, then the value of r_l is the Hamming distance between vector-word K_l and the vector-retrieval independent variable Z. If summation is defined in (1) and (2) as conjunction, then r_l indicates coincidence (with accuracy up to masked digits) of the retrieval independent argument and the word stored in the photomatrix adaptive memory.

In the simplest case the indicators of coincidence, which are threshold devices, record the value that exceeds the zero threshold, thus forming the vector-function R, adequate to the position address of the word coincident to code Z. This word can be rewritten by means of the address register to the output register and can be transmitted over a communications channel.

The functional diagram of the photomatrix associative memory cell, in which the following microoperations required for operation in the optoelectronic associative memory are realized, is presented in Figure 1, b: parallel electric recording of the N-digit input word by the given addresses ("Electric recording"), parallel optical recording of L, N-digit binary words ("Optical recording"), parallel reading of the N-digit binary word by the given address ("Read") and parallel realization of the function R in the L X N-page ("Interrogation").

Each cell of the photomatrix associative memory consists of a photodetector 1, memory element 2, write-read elements 3 and 4 and comparison element 5. The cells in the memory are joined by two orthogonal line systems. The first of them consists of N pairs of digit write/read lines Z_n, $\bar{Z}_n$ that join the matrix columns and the second consists of L address lines A_l and L coincidence lines R_l that join the matrix rows. The system of address lines A_l guarantees dictionary access to the memory matrix with electric write/read. The coincidence lines $\{R_l\}$ guarantee fulfillment of the function r_l for each word stored in the memory and as a special case fulfillment of function r_l--reading of the digit cuts of words. The photodetector can be regarded as a supplementary access for writing information to each cell. In the general case functioning of the photomatrix associative memory cell is described by means of the system of equations

$$\begin{cases} \dot{k}_{ln}(t+1) = Z_n(t)a_l(t) + k_{ln}(t) + k_{ln}(t+1), \\ \tilde{k}_{ln}(t+1) = \hat{k}_{ln}(t+1)a_l(t+1), \\ r_{ln}(t+1) = [\hat{k}_{ln}(t+1)Z_n(t+1) + \overline{k_{ln}(t+1)}\,\overline{Z_n(t+1)}]M_n, \end{cases} \quad (3)$$

where $k_{ln}(t + 1)$ is the status of flip-flop 2 at time (t + 1), $k_{ln}(t + 1)$ is the n-th digit of the word read from the Z-, $\bar{Z}$-lines at time (t + 1), r_{ln}(t + 1) is the value of the "Equivalence" function realized in comparison circuit 5 on

lines $\{R_l\}$ for each photocell, M_n is the value of the n-th masked digit and a_l is the signal from address line A_l.

Circuitry and design of the photomatrix associative memory. The circuitry of the photomatrix associative memory cell shown in Figure 2, a contains photo flip-flop, modified with respect to [5], on MDP transistors T1-T4 and a photodiode FD. MDP transistors T5 and T6 operate as through keys for writing and reading information. The logic circuit on transistors T7, T8 and T9, T10 is two AND circuits whose inputs are connected to the arms of the flip-flop and the interrogation lines, respectively, as shown in Figure 2, a. The outputs of the AND circuits are connected to the OR line, realized by coincidence lines $\{R_l\}$.

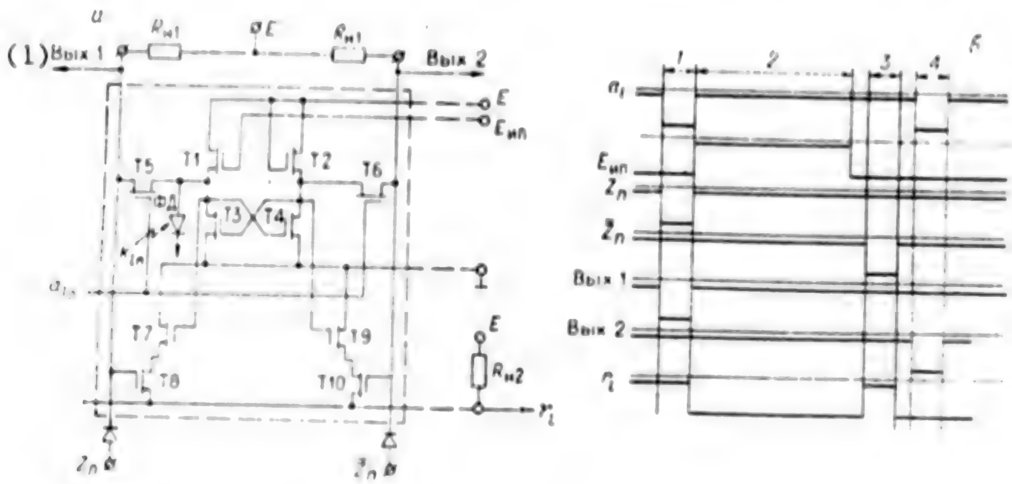


Figure 2.

Key:
1. Output

Let us consider the functioning of the cell on the example of the following sequence of microoperations: electric writing of "0," optical writing of "1," interrogation by independent variable Z = "1" and reading of "1." The pulse diagram of the control (a_l and E_{ip}), input (Z_n, $\bar{Z}$, k_{ln}) and output (Vykh 1, Vykh 2, r_l) information signals is shown in Figure 2, b, where 1 is electric writing, 2 is optical writing, 3 is interrogation and 4 is reading.

Electric writing is accomplished in the photomatrix associative memory cell by feeding to the corresponding address line A_l a_high potential which opens keys T5 and T6 and switches the digit lines Z_n and $\bar{Z}_n$ to the inputs of the flip-flops. Potentials corresponding to the value of the digit of the written word in paraphase code are fed to this pair of digit lines. A nigh potential whose value corresponds to the condition of nondestructive reading, is fed through the load to the digit lines in the case of a masked digit. Either the status of the flip-flop is confirmed or the arm of the flip-flop with high potential is discharged through the grounded digit line during writing, while the opposite arm is charged through the load transistor to a high potential. Thus, writing

a zero in the flip-flop corresponds to a high potential on the channel of transistor T4.

During optical writing, load transistor T1 is cut off by the zero potential on the gate (see E_{ip} in Figure 2, b) so that the photodiode is disconnected from the conducting circuits during the microoperation of optical writing and operates in the photocharge storage mode. The anode of the photodiode is actually connected to the input of the amplifier stage on MDP transistors T4, T2 and T3, surrounded by positive feedback. Variation of voltage on the anode of the photodiode, caused by luminous flux with energy of an optical "1," leads to triggering of feedback, and the photodiode capacitor is discharged through feedback transistor T3. In this case the voltage on the opposite arm of the flip-flop is increased to the level of a logic "1."

The process of optical writing is completed by feeding a cutoff potential to the gate of T1. In this case the information entered optically is statically memoryized and stored until cutoff of the power supply source. The photo flip-flop in this mode is approximately 10^{n} times less sensitive to the output of the luminous flux, since the photocurrent should considerably exceed the current passing through the load transistor.

Potentials corresponding to the inverse word-independent variable (wtih respect to the word during writing) of interrogation in paraphase code are fed to the paris of digit lines when performing the microoperation "Interrogation." The zero potential on both lines correpsonds to the masked digits. IF the paraphase code of the independent interrogation variable on the lines coincides with the status of the memory element, the comparison circuit based on transistors T7-T10 is in the conducting state and current passes through load R_{n2} along line R_1. If there is no coincidence, then there is no current in load R_{n2}. Words can be read from the photomatrix associative memory by feeding an address signal along line A_1 (see a_1 in Figure 2, b). In this case information is read from the flip-flop through lines Z_n, $\bar{Z}_n$ on the load resistors in paraphase code. Bypasses made in the form of keys or diodes D1 and D2 (see Figure 2, a) are required in order that the output resistors of the interrogation register (see Figure 1, a) do not shunt the output signals of the cell. The microoperations of electric and optical writing, interrogation and reading can be followed in an arbitrary sequence according to the control microprogram of the photomatrix associative memory. This guarantees adequate functional completeness, flexibility and adjustability of the optoelectronic associative memory to provide a calculating algorithm for solving a specific associative retrieval problem.

Experimental models of a photomatrix associative memory with 12 X 12 dimensions of the photocells was manufactured in the form of an integrated circuit by p-channel MDP technology with silicon gate. A photograph of the microcircuit crystal is presented in Figure 3, a. The dimensions of the photomatrix associative memory crystal were 5 X 5 mm, the spacing between photodetectors was 0.3 mm and the dimensions of the photodetecting surface was 0.1 X 0.1 mm. The photosensitive element of the circuit was a p-n junction, which is a specially magnified channel-source region in one of the arms of the flip-flop circuit. The photosensitive element operated as a photodiode biased in the opposite direction and the photocharge storage mode was used to write optical information

[6]. The photomatrix associative memory crystals were placed in a planar 48-lead housing with transparent window (see Figure 3, b).

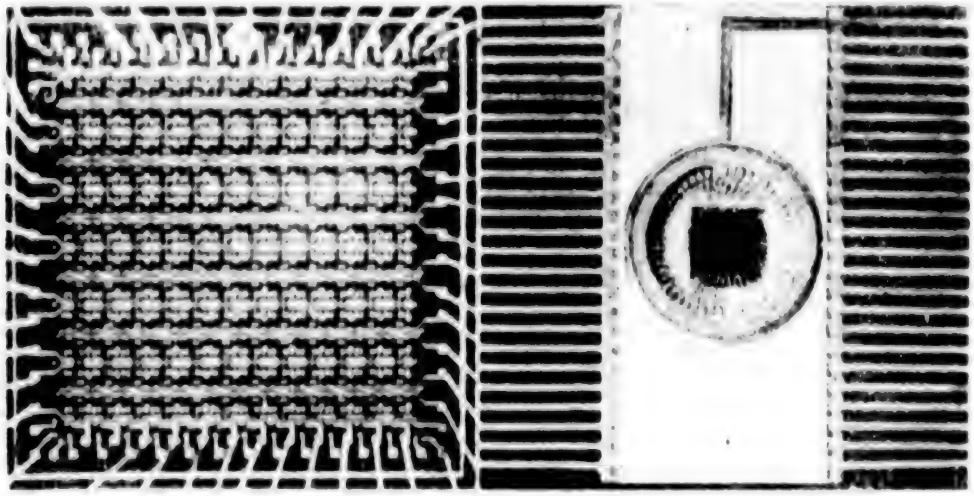
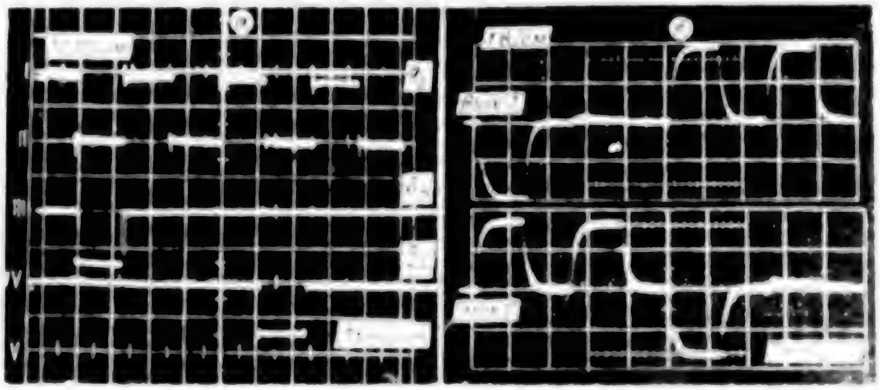


Figure 3.

Experimental results. Discussion of results. The photoelectric and functional parameters of the photomatrix associative memory were measured by using equipment [7] consisting of a multichannel programmable generator, regulated power supply sources E1 and E2 and a coherent light source ($\lambda = 0.63$ μm) that focuses the optics and adjusting accessories.

The multichannel programmable generator was used to control the control diagram of the photomatrix associative memory photocell, which was monitored by a five-channel oscillograph. The luminous flux focussed to a spot 50 μm in diameter was recorded by a calibrated photodiode and was directed to the photosensitive surface of the photomatrix associative memory cell simultaneously with delivery of the control diagram to the corresponding lines.

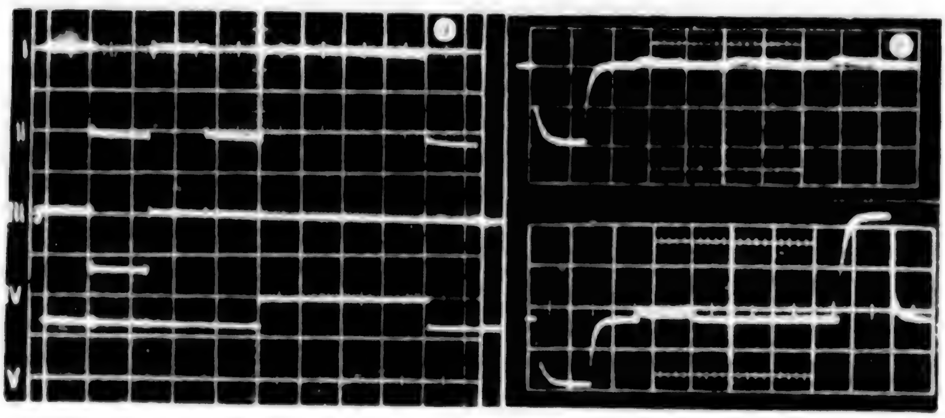
Figure 4.

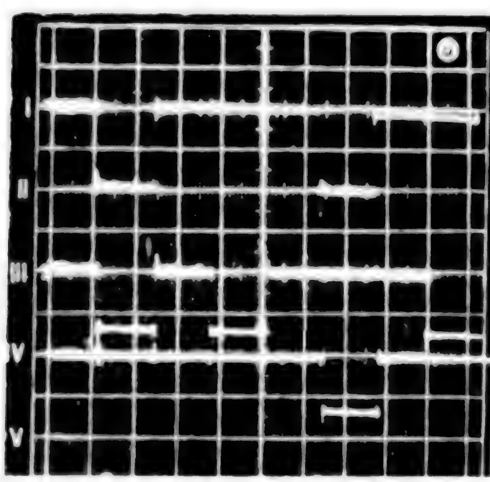


Tests containing pairs of microoperations: "Electric write-read," "Optical write-read" and "Electric write-interrogation" (Figures 4-6), were used for convenience in observations of the signals on the oscillograph.

An oscillogram of the control voltages for the "Electric write-read" test is shown in Figure 4, a and an oscillogram of the response of the cell read from load resistors R_{n1} is shown in Figure 4, b. The first group of pulses on lines A_1, Z_n and $\bar{Z}_n$ denote writing of information $Z = 1$, $\bar{Z}_n = 0$ to the flip-flop and in this case the voltage on the load resistors R_{n1} follows the written information (Figure 4, b). The second pulse through address line A_1 (see Figure 4, a) interrogates the status of the flip-flop. The third group of pulses in Figure 4, a determines writing of $Z_n = 0$, $\bar{Z}_n = 1$ to the flip-flop, while the fourth pulse on line A_1 interrogates the flip-flop.

Figure 5.





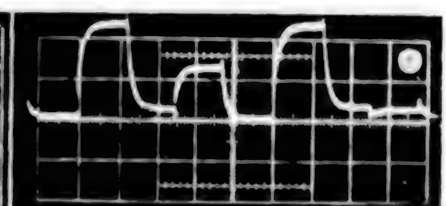


Figure 6.

Oscillograms of the "Optical write-read" test are shown in Figure 5, a and b. The oscillogram of Figure 5, a illustrates the photocell control diagram. The first pulse through the address line authorizes presetting of the flip-flop to status "0." To do this, the code "0" and "1" is fed along lines Z_n and $\bar{Z}_n$ such that the capacitor of the photodiode is charged as a result of resetting. The second pulse checks the status of the flip-flop through the address line. Load transistor T1 (see Figure 2, a) is cut off by the signal E_{ip} (see Figure 5, a) during the next "optical write" cycle itself. In this case the photodiode operates in the photocharge storage mode. The third pulse through address line A_1 checks the results of writing. The response of the photocell to the test is presented in the oscillograms of Figure 5, b and c for the cases $k_{1n} = 0$ and $k_{1n} = 1$.

The "Electric write-interrogation" test (Figure 6) was used to illustrate the operation of the photomatrix associative memory in the comparison mode with the retrieval independent variable. The first pulse through the address line (see Figure 6, a) authorizes presetting of the flip-flop to status "0" by the potentials on digit lines Z_n and $\bar{Z}_n$. The contents of the flip-flop with code Z_n and $\bar{Z}_n$ are compared during the next cycle. The third cycle is writing to flip-flop "1" and the fourth cycle is comparison to the same code. An oscillogram of the output signals on load circuit R_{n2} is shown in Figure 6, b. The result of comparison is shown in the second and fourth cycles.

The threshold energy of switching the flip-flop did not exceed 10^{-12} J/cell at power supply and control voltages of -12 V for emission of wavelength $\lambda = 0.63$ μm of a helium-neon laser. The sensitivity of the photocell can be increased by reducing the power supply voltages. In this case the noise resistance of the circuit is reduced. Another factor that limits the sensitivity of the circuit includes asymmetrical spurious pulse noise, occurring during switching of the load MDP transistor. However, a decrease of the effect of pulsed noise due to a decrease of amplitude E_{ip} is possible.

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UDC 776

INCREASING ELEMENT SIZE STABILITY IN PROJECTION PHOTOLITHOGRAPHY

Novosibirsk AVTOMETRIYA in Russian No 2, Mar-Apr 82 (manuscript received 20 May 80, in final form 9 Mar 81) pp 86-92

[Article by V. B. Gurskiy and R. Ye. Pyatetskiy, Minsk]

[Excerpt] Experimental results. The range of the mean rates of development of exposed strips in regions with different thicknesses of SiO_2 film and photoresist with and without control of exposure time on the basis of model function $H^*(R_0)$ was compared to check the model. For this purpose, four plates with stepped relief of the oxide (Figure 6) were manufactured by photolithography and selective etching of thermal SiO_2. The cross-hatched vertical strips represent regions with SiO_2 film, while the blank strips represent pure silicon. Each strip of oxide has a thickness from 1 to 0.3 μm, which varies by 60-90 nm from strip to strip.

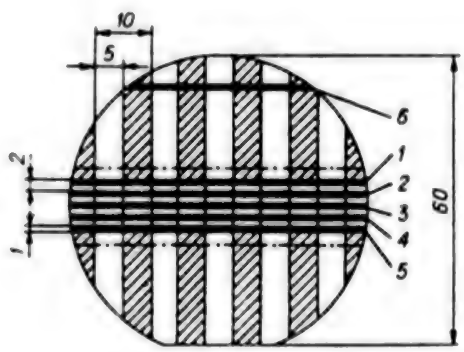

Figure 6. View of Developed Plate

AZ-1350J resist 480-560 nm thick was applied to the plate. The reflection coeffcient (λ = 436 nm and the width of the sounding beam was diaphragmed to 2 mm) was measured on a Beckman UV-2500 spectrophotometer in the region determined by the dashed lines, in the center of each of the SiO_2 strips and one of the SiO_2 strips with zero thickness (a total of 28 points). The six horizontal lines (their dimensions and position is shown in Figure 6) were then exposed on each strip. Exposure was also carried out on an EM-542A duplication and blending machine with ZhSS and ZhS-12 filters (λ = 436 nm). Each of five central lines was exposed with its own exposure time, which varied from τ_{max} to 0.6 τ_{max}

at intervals of 0.1 τ_{max}. The optimum exposure time for the given installation and the resist, used in the commercial exposure mode, was taken as τ_{max}. The sixth line was exposed with time of τ_{max} and was used to determine the conditions of development.

The plates were dried at 100°C for 20 min after exposure by the method suggested in [18] to equalize the residual concentration of inhibitor $M(z, H_e)$ through the thickness of the photoresist film.

The exposed strips were developed in an AZ: H_2O = 1:1 solution at 20°C. The top (sixth) strip was developed first and the time t of total development was determined. The entire plate was then immersed in the developer and was developed for time $t_1 < t$ such that none of the five central strips were fully developed. A layer of aluminum 20-30 nm thick was sprayed onto the plates after development. The depth of the strips etched in the resist on each of the oxide steps were measured for five exposures on an MII-4 interference microscope with accuracy of 20-30 nm. The measurement data for one of the plates are presented in the table.

Нормированное время экспозиции τ/τ_{max} (1)	Коэффициент отражения R_0, % (2)						
	20,6	35,7	18,1	33,1	6,1	8,8	25,5
	Глубина травления, нм (3)						
1	447	270	330	290	466	399	330
0,9	421	268	308	270	440	358	320
0,8	339	218	260	234	355	270	285
0,7	270	117	150	178	270	191	211
0,6	194	105	140	162	220	164	164

Key:
1. Normalized exposure time τ/τ_{max}
2. Reflection coefficient, R_0, percent
3. Depth of etching, nm

The results of the measurements are shown in Figure 7 in the form of histograms. Histogram a corresponds to depths of etching of strips exposed during τ_{max}. Histogram b shows the effect of exposure control. It was plotted in the following manner. The required exposure time τ^* was determined for each SiO_2 strip of the considered plate by the reflection coefficient R_0 measured for it from the approximated curve $H^*(R_0)$ (the lower branch of curve $H(R_0)$ corresponding to h_{ph} = 525 nm in Figure 5 was taken as curve $H^*(R_0)$. The depth of etching l^*, corresponding to exposure time τ^*, was then determined by interpolation on the basis of data of the table of depths for this plate. Histogram b was then plotted on the basis of the values of l^* found in this manner.

It is obvious from the histograms of Figure 7 that the range of depths of etching of exposed strips for regions of plates with different thicknesses of SiO_2 film and photoresist decreased by a factor of 2.5 as a result of exposure control. The range of mean rates of development also decreased by the same factor, which is the consequence of equalizing the residual concentration of inhibitor and is good agreement with the calculated value.

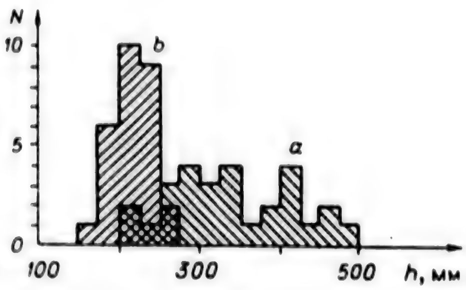

Figure 7. Histograms of Depths of Etching: a--without exposure control; b--with exposure control

Conclusions. One of the possible approaches to solving the problem of reducing the instability of the element size in projection photolithography, based on measurement of the energy reflection coefficient R_0 at local points and exposure control by it at these points, was investigated at the paper. In this case control was accomplished by the dependence of exposure time H on R_0 calculated from the model for each specific substrate-film system. It was shown and confirmed experimentally on the example of Al-Ph and $Si-SiO_2-Ph$ systems that exposure control by the suggested method during generation of the figure on relief substrates permits a reduction of the range of rates of development of the elements on the plate at least by a factor of 2-3 compared to the case without exposure control. Equalization of the rates of development should result in a decrease of the range of element size in approximately the same proportion. However, a precise answer to the question of reducing the instability of size during exposure control can be obtained only by direct experiment.

The functions $H(R_0)$ for all the substrate-film systems used in production of the IS (integrated circuit) must be calculated and entered in the computer controlling the operation of the image generator for practical realization of the method according to the existing model. The exposure time H is proportioned according to the model function $H(R_0)$ at each exposed point of the substrate on the basis of the measured reflection coefficient R_0 for a specific computer system. Thus, the second problem requiring solution is to develop a high-speed device for local real-time measurement of the energy reflection coefficient R_0.

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PHOTODETECTOR BASED ON SCHOTTKY BARRIER AND ISOTYPE HETEROJUNCTION

Novosibirsk AVTOMETRIYA in Russian No 2, Mar-Apr 82 (manuscript received 9 Oct 81) pp 105-107

[Article by B. S. Vakarov, I. S. Vakarova and V. N. Vishnyakov, Odessa]

[Text] Photosensitive structures having sign inversion in the photocurrent spectrum and that are thus of specific interest of the viewpoint of their use in optoelectronics devices [4] have been reported on in a number of papers [1-3]. The indicated feature of photocurrent is determined by separation of the light-generated current carriers by two space charge layers located at different depths with counterdirectional internal electric fields.

The results of investigating the photoelectric properties of the metal--$n^{+}Al_xGa_{1-x}As$-nGaAs structure, which is a combination of a Schottky barrier (metal--$n^{+}Al_xGa_{1-x}As$) and a heterojunction ($n+Al_xGa_{1-x}As$--nGaAs) are presented in the paper. The presence of two nonequivalent space charge regions in the given structure determines the shape of the spectral distribution curve of photocurrent: two points are observed in it in which the photocurrent changes sign.

Al(GaAs)--GaAs isotype heterojunctions were created by liquid-phase epitaxial growing on a GaAs substrate of $Al_xGa_{1-x}As$ solid solutions with different molar fraction of aluminum ($0.2 < x < 0.7$). The epitaxial layers were alloyed with tellurium and their thickness after surface treatment for application of the metal layer was 20-30 μm. The grown solid solutions had variable composition in a direction perpendicular to the surface of the layer and the width of the forbidden zone decreased as the distance from the interface decreased with gradient of approximately 0.01 eV/μm. The carrier concentration in the GaAs substrate was $\sim 10^{16}$ cm^{-3} while the level of alloying of the epitaxial layer was appreciably higher at 10^{18} cm^{-3}. Ohmic contact to the substrate was accomplished by fusion of In [5] and the Schottky barrier was accomplished by chemical precipitation [6] of a semitransparent layer of gold onto the surface of the solid solution, treated by standard methods.

The photoelectric properties of the structure were investigated by the synchronous detection method in the short-circuiting current mode with zero bias and with delivery of bias of both polarities. The structure was illuminated from the direction of the solid solution.

The results of measuring the structural photocurrent distribution j_f of structures with different value of parameter x at $\sim$ 300 K are shown in Figure 1. The photosensitivity spectra contain two points of sign inversion of photocurrent and one point of inversion (a) was observed for all the investigated structures at $\hbar\omega \approx$ 1.43 eV, which corresponds to the width of the forbidden zone of GaAs (E_{g2}), while a second point of inversion "b" was located in the spectral range of 1.65-2.05 eV as a function of the value of parameter x. Its position coincides rather well with the width of the forbidden zone of $Al_xGa_{1-x}As$ on the boundary with the metal (E_{g1}).

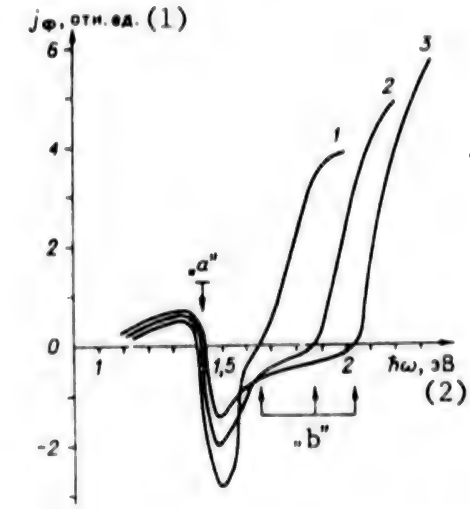

Figure 1. Spectral Distribution of Photocurrent j_f with Zero Bias of M--$n^+Al_xGa_{1-x}As$--nGaAs Structures with Different Molar Fraction of Aluminum x: 1--0.2; 2--0.4; 3--0.7

Key:
1. Relative units
2. eV

A zone diagram of the investigated structure is shown in Figure 2. It was taken into account when plotting it that the break in the valency zone is close to zero [7] in the GaAS--Al(GaAS) heterojunction and that the height of the barrier ϕ_V is determined by the ratio $\phi_V \approx (2/3)E_{g1}$ for metal--n $Al_xAs_{1-x}As$ Schottky barriers ($0.2 < x < 0.7$) [8]. Three types of optical junctions are noted in the diagram which can be realized at different photon energies of the investigated spectral band.

According to [1], the photocurrent of a structure with two potential barriers is described by the expression

where j_{f1} and j_{f2} are the photocurrents related to separation of the light-generated carriers by the fields of barriers I and II, respectively, and k is the ratio of the differential conductivity of barriers II and I. Photocurrent in the photon energy range of $\hbar\omega$ = 1.0-1.43 eV ($\phi_V < \hbar < E_{g2}$) is determined by electron emission from the metal to the epitaxial film and by their separation in the field of the Schottky barrier ($j_{f2} = 0$, $j_f > 0$). Absorption in the GaAs

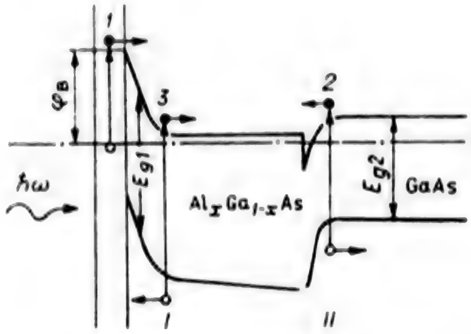

Figure 2. Energy Zone Diagram of M--n^+Al(GaAs)--nGaAs Structure: 1--photoemission of electrons from M to Al(GaAs) solid solution; 2--separation of carriers by field of heterojunction II; 3--separation of carriers by field of Schottky barrier I.

substrate begins as the photon energy increase ($E_{g2} < h\omega < E_{g1}$), since photons with energy less than E_{g1} freely pass through the wide zone "window." Moreover, absorption initially proceeds beyond the region of the "dip," since the optical width of the forbidden zone in this region is increased due to the presence of an inversion layer.

The light-generated carriers are separated by the electric field of the heterojunction and inversion of the photocurrent sign and a sharp increase of it in the negative zone occur ($j_{f2} > kj_{f1}$, $j_f < 0$). However, beginning at photon energy $\hbar\omega \approx 1.5$ eV, a decrease of the negative photocurrent is observed, possibly related to the fact that the main absorption occurs directly in the region of the dip of the zone of conductivity and the greater part of the light-generated electron-hole pairs recombines rapidly, making no contribution to photocurrent.

The "window" effect ceases to operate with a further increase of photon energy ($h\omega > E_{g2}$), the usual interzone absorption in the solid solution begins and the photocurrent again changes its sign since the photocarriers are separated in this case by the field of the Schottky barrier ($j_{f2} = 0$, $j_f > 0$).

It should be noted that the photosensitivity in regions 1 and 2 is much less than that in region 3, since the photocurrent of the Schottky barrier is much less than that in the region of the natural absorption of the semiconductor due to electron emission from the metal [9], while the surface potential barrier Φ_V must be overcome by the carriers generated in the GaAs substrate and separated by the field of the heterojunction.

Moreover, the value of the negative maximum photocurrent in the range of photon energies of $E_{g2} < h\omega < E_{g1}$ depends on the molar fraction of aluminum x in the solid solution (see Figure 2) and decreases as the value of x increases, i.e., as the width of the $Al_xGa_{1-x}As$ forbidden zone increases. A similar principle is obviously related to an increase of the energy gap in the zone of conductivity in the heterojunction, the value of which determines the fraction of electrons passed through the heterojunction and accordingly the value of photocurrent.

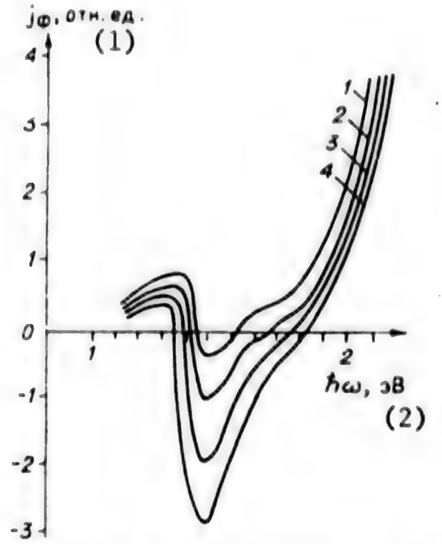

Figure 3. Spectral Distribution of Photocurrent of Structure with x = 0.3 at Different Bias Voltages U, V: 1-- -1.0; 2-- -0.5; 3--0; 4-- +2

Key:
1. Relative units
2. eV

The results of investigating the effect of bias voltage on the photosensitivity of the structure are presented in Figure 3. The observed variation of the spectral distribution of photosensitivity and the position of point "b" of sign inversion of photocurrent were determined by variation of the differential conductivity of barriers I and II (variation of the value of k in the expression for j_f). Indeed, the height of the potential surface barrier ϕ_V increases when a negative bias is applied (which corresponds to reverse bias for a Schottky barrier) and the height of the heterojunction barrier correspondingly decreases, which also leads to more effective separation of the photogenerated carriers by the field of the Schottky barrier. Accordingly, the photocurrent in the region of $h > E_{g1}$ increases, it decreases in the region of $E_{g2} < h\omega < E_{g1}$, while the point of inversion "b" shifts toward lower photon energies. In similar fashion, the bias of opposite polarity has an inverse effect on the spectral characteristics of the photocurrent.

It should be noted that the presence of three sections differing by sign in the spectrum of photocurrent is observed at ∿ 300 K, whereas a negative maximum is either generally not observed in the photodetectors suggested in [2] or it is detected only at ∿ 80 K. This difference is related to the fact that the photoelectrons emitted from the metal to the semiconductor and separated by the field of the Schottky barrier pass to the external circuit almost unhindered in the investigated structure. For the same reason the voltage drop $\Delta\phi$ occurring on junctions I and II when the structure is illuminated by light with photon energy $h < E_{g2}$ is small and accordingly the spectral position of point "a" of the sign inversion should be weakly dependent on the light intensity [1].

When the structure is illuminated by light absorbed in the GaAs substrate, the photogenerated electrons are forced to overcome the potential barrier ϕ_V, which leads to their accumulation in the epitaxial layer and to an increase of $\Delta\phi$. Accordingly, the spectral position of point "b" of the inversion should depend to a greater extent on the illumination. Nevertheless, this dependence is not very strong due to the fact that j_{f2} drops sharply in the considered structure, as was indicated earlier, when the photon energy approaches the value of E_{g1}, while the value of j_{f1} increases sharply.

The lux-ampere characteristic of the specimens remained linear while the spectral position of the points of inversion of the sign of phtocurrent "a" and "b" remained unchanged in the investigated range of illuminations (up to $\sim 10^{-3}$ W/cm^2) with accuracy up to 0.01 eV. This range of illuminations is an order less for the structure suggested in [1].

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SOFTWARE

AUTOMATIC DATA BASE DEVELOPMENT - A QUALITATIVELY NEW STAGE IN DEVELOPMENT OF STATISTICS

Moscow EKONOMICHESKOYE SOTRUDNICHESTVO STRAN-CHLENOV SEV in Russian No 6, Jun 82 pp 30-32

[Excerpts from article by Valeriy Nazarov, CEMA Secretariat]

[Excerpts] Considering the importance and difficulty of automatic data base development in CEMA member countries, a meeting of the CEMA Standing Commission on Cooperation in the area of Statistics instructed that a Temporary International Scientific-Research Collective be set up within the framework of the Commission, to consist of specialists of interested CEMA member countries to develop the theme "Creation and Application of Automatic Data Bases for the Unified Computer System (YeS EVM)". The work program of the Temporary International Scientific-Research Collective includes the following design phases for the YeS EVM automatic data base:

--principles of developing and applying automatic data bases;
--standard technical assignment for developing and implementing automatic data bases;
--standard technical draft for developing and implementing automatic data bases.

The statistical agencies of individual CEMA member countries already have automated data bases, but most of them are generally intended for commercial purposes and do not fully satisfy the requirements of statistical services. By studying the experience which has been gained in various countries in operating them and by analyzing the operation of existing automatic data bases, the Temporary International Scientific-Research Collective was able to combine the efforts of the countries in developing and defining a unified conception and higher requirements for the statistical data base.

In the first stage of cooperation, the Temporary International Scientific-Research Collective, according to the plan, developed the principles for creating and implementing the ASGS [Automated State Statistics System] automated data base for the Unified Computer System. This document served as the coordinated foundation for scientific-research work to develop statistical data bases for interested CEMA member countries, and was aimed at expanding

international cooperation in the area of statistics. It was developed on the basis of analyzing existing experience in CEMA member countries on this matter in consideration of the prospects for development of automated statistical data processing systems.

The principles for creating and implementing the Unified Computer System automatic data base represent the coordinated opinion on the defintion of automatic data base, its place within the automated state statistics system and its structure, construction and operation conditions. These concern the system which controls the data base, its functions and singularities, allowing for the specific properties of statistical data and the relationship between the data base control system and operating system, the data base control system communications facilities and problems involved in implementing the data base control system. A data base must support the handling of regular jobs, information-reference service and actualization. Software is provided for solving regular problems which facilitate on-line updating of the data base, which increases the accuracy of statistical information and reduces the difficulty of making changes in the data base.

The software allows the data base to be expanded freely, and permits new tasks to be entered without changing the logical or physical organization of the base.

The draft has definite advantages over the data processing systems now in use in the statistical agencies of a number of CEMA member countries because of the rational utilization of the data base and modern computer technology.

The automatic data base is considered as a subsystem of an automated statistical system which provides the following integrated data processing capabilities:

--one-time input of minimum amount of source data, repeated utilization of the data and conversion to provide various statistical processing and corresponding output tables;
--the availability of an interrelated system of statistical indicators used to characterize a particular phenomenon as a whole, or individual aspects thereof;
--tie-in of various territorial levels in the processing of statistical data.

In the next stage of activity, the Temporary International Collective develop a standard technical assignment for the creation and application of the Unified Computer System automatic data base.

The main advantage of the standard technical assignment is its integrated approach to problems which are to become the subject of analysis of the draft treatments of the automatic data base. This creates the prerequisites for unifying the draft treatments for the automatic data base within the framework of international cooperation. It was possible in drawing up this document to generalize materials which can be used for statistics as well as other branches and departments.

The next stage in the activity of the Temporary International Scientific-Research Collective in 1981 was the development of a Standard Technical Draft for the creation and application of the ASGS automatic data base for the Unified Computer System. A necessary condition for the functioning of the automatic data base is the availability of a unified statistical methodology at different levels -- from bottom to top -- and a system for gathering and processing data from the statistical agencies of the countries. The draft indicates that the data base is to be created in stages, allowing for the degree of preparedness of the information-reference fund and available ASGS automatic data base hardware.

The goal of creating the standard technical draft includes the following:

--promoting the development of national automatic data bases to the level provided by the standard technical assignment for creation and application of the ASGS automatic data base;
--creating methodological foundations for promoting and developing national automatic data bases which will provide ASGS data exchange among CEMA member countries in the future;
--developing standard treatments and promoting the creation of new, and the development of existing, automatic data bases in the CEMA member countries considering specific conditions and singularities.

The standard technical draft also deals with such questions as the organizational and functional structure of the automatic data base, the interaction between automatic data bases at different levels with data bases in other automated systems, information support, data base operating conditions, automatic data base hardware and software and efficiency criteria.

The sections of the standard technical draft contain alternative draft treatments which are intended for use as methodological guidance. In examining organizational and functional structure, the technical draft generalizes the existing directions regarding automatic data base creation which were taken into account in developing the draft. The criteria which determine the choice of treatment include the requirement for analytical information at the corresponding levels, the amount of data, including source, that processed and stored in the automatic data base and that transmitted, as well as the hardware composition.

One of the essential evaluation criteria for the automatic data base is the simplicity and convenience with which a subscriber (user) -- the statistician -- can use it. The automatic data base outputs the requested data, processes it, and outputs ready results in the required form: reports, groupings, trends, etc.

The software structure in the standard technical draft is made up of a data base control system, a data base processing system and a remote data processing system.

These components interact closely and are themselves divided into subcomponents,

with the latter being divided further into modules.

The ASGS automated data base control system is the fundamental part of the automatic data base and, from the viewpoint of the overall structure of the data base, is the programming system which allows the applications programs to communicate with the data base.

In contrast to previous documents, the technical draft develops efficiency criteria for the application of the automated statistical data base and formulates the concepts of efficiency. The latter are based on exploiting the savings achieved by using the ASGS automatic data base as compared with the design, introduction and operating costs.

The 38th session of the CEMA Standing Commission on Cooperation in the Area of Statistics adopted the Standard Technical Draft for the creation and application of the ASGS automatic data base for the Unified Computer System, noting that it had been fulfilled successfully. Delegations from Bulgaria, Hungary, the Socialist Republic of Vietnam, GDR, the Republic of Cuba, the Mongolian People's Republic, the USSR and Czechoslovakia agreed to use this draft to create and implement ASGS automatic data bases, allowing for the specific conditions present in those countries.

At the same time, automatic data base organization in state statistical agencies requires further investigation both on the theoretical and practical plane. In this connection, the CEMA Standing Commission on Cooperation in the Area of Statistics recognized it advisable, at the 38th meeting, to begin work in 1982 on the theme "Creation and application of distributed ASGS automatic data base for the Unified Computer System". In order to achieve quick results, this theme will be developed within the framework of the Temporary Scientific-Research Collective. The GDR delegation agreed to coordinate the work on this theme. A distributed automatic data base is a system of interconnected local automatic data bases set up following unified principles of methodological and information support and hardware and software, combined by a statistical data teleprocessing system. This combination of local automatic data bases makes it possible to bring the location at which data is stored closer to its sources, to reduce the overall flows of statistical data significantly and to create favorable conditions for the use of this data while reducing the relative cost of automatic data base operation.

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ANALYSIS OF PROGRAM RELOCATION METHODS FOR K580IK80 MICROPROCESSOR

Kiev UPRAVLYAYUSHCHIYE SISTEMY I MASHINY in Russian No 3, May-Jun 82 (manuscript received 17 Jun 81) pp 35-38

[Article by engineer Oleg Antonovich Parnyuk, Candidate of Technical Sciences Aleksandr Kirillovich Teslenko and engineer Aleksandr Aleksandrovich Shevchenko, Kiev]

[Excerpts] The simplicity of realizing a functionally complete computer or control system and the comparatively high speed (500,000 R X R format operations per second) permit the use of the K580IK80 or KR580IK80A microprocessor for design of both the simplest controllers that control various types of production and measuring equipment and specialized computers that operate with small memory capacity and for realization of comparatively complex multiprogram single-processor or multiprocessor systems.

The instruction system of the K580IK80 microprocessor guarantees addressing of 64K bytes of memory by indicating a single component--the absolute address in the second or third byte of the instruction in one of the register pairs or in the stack. This method of addressing is quite satisfactory for most applied problems when the programs are arranged by fixed, previously determined addresses. However, when realizing complex systems that dynamically distribute the memory resources among program components, the deficiencies of the indicated method of addressing are revealed. This is explained by the problems arising during loading and automatic connection of individual modules into a unified program, development of subroutine libraries, development of position-independent programs and in all other cases when the absolute program addresses cannot be indicated beforehand.

The problem of program relocation is solved in large and minicomputers by apparatus formation of effective addresses in the form of the sum of several components, for example, the contents of the base and index registers and resetting, which considerably simplifies adjustment of the program module for performance in the required absolute addresses.

One of the methods of shifting program modules in microcomputers based on the K580IK80 microprocessor is correction of the absolute addresses of the corresponding instructions of the program to be relocated. The operations performed in this case are largely analogous to operations in correction of

address constants during adjustment of program modules in large and minicomputers. The differences include the fact that not only the address constants but also the address parts of the control transfer instructions, subroutine call and so on are corrected when using microcomputers based on the K580IK80 microprocessor. This results in an increase of facility modules due to significant expansion of the relocation dictionary.

Another method of program relocation for microcomputers based on the K580IK80 microprocessor inculdes formation of the effective address through programming by addition of several components, which can be accomplished by using the instruction for adding the contents of DAD register pairs that load the result into the HL register pair. Control transfer by the formed effective address can be achieved by using indirect addressing instructions.

We shall subsequently assume that the effective address consists of two components--a base and shift. This does not affect the essence of the method under consideration, whereas formation of the effective address is simplified.

A program that adds the components of the effective address can be included in the text of the initial program as a macroinstruction or can be summoned as a procedure. Shifting is controlled as a macroinstruction parameter (procedure). The base can be given by the following methods: the contents of the instruction counter is used as the base for the first of them and the base address is stored in the memory or the register pair of the microprocessor by the second.

The main advantage of the first method includes the fact that it permits one to create position-independent programs. The contents of the instruction counter become accessible for calculations in the K580IK80 microprocessor only upon execution of subroutine call instructions by absolute address or second startup instructions. In both cases the procedure of calculating the effective address must be arranged for some fixed addresses to guarantee position independence.

It follows from the given data that macroinstructions occupy two or three times more memory and require three-five times more cycles for execution than the corresponding instructions of the microprocessor. Taking into account that the programs for the K580IK80 microprocessor contain an average of no more than 20 percent transfer instructions with respect to the absolute address, the use of the considered microinstructions increases the volume of programs no more than 1.2-1.4-fold and the execution time 1.4-1.8-fold.

Comparing the considered methods of program relocation of microcomputers based on the K580IK80 microprocessor, one may note the following.

The main advantage of the program relocation method by correction of absolute addresses is that it has no effect on the volume and speed of the program to be relocated. All expenditures related to relocation occur in the phase of preparing the programs for execution. However, this places higher reuqirements on the systems programs since the structure is complicated and the volume of the entity files is increased. The given method can be realized more fully

and effectively when using a sufficiently high-speed high-capacity external memory (for example, NMD [magnetic disk store]).

At the same time programs whose relocation is guaranteed by using the considered macroinstructions, in view of the essentially simpler structure of the entity module permitted by them, may guarantee more efficient use of the external memory, which permits the use of papertape carriers. Moreover, the methods of relocation when using the considered macroinstructions can be used with sufficiently simple operating systems. Thus, for example, the relocation programs can be assembled by generating an absolute entity code. These assemblers (resident and cross-over) have now become most widely distributed for microcomputers based on BIS [large integrated circuit] of series K580, produced by Soviet industry.

The capability of relating the time expenditures connected to program relocation to the phase of their preparation for execution is an advantage of the method of address correction in those cases when no dynamic program relocation is required. This method can also be used when the time expenditures for relocation are considerably less than the time of program execution. In turn, the method based on program calculation of the effective address permits one to achieve a definite time advantage if the time of program adjustment by address correction is comparable to the time of execution and cannot be eliminated from the total functioning time of the system.

Despite the fact that there is no hardware in the K580IK80 microprocessor that guarantees formation of the effective addrees in the form of the sum of several components, the problem of program module relocation can be solved by programming using one of the considered methods. Depeding on the specific requirements on the system, the capacity of its main memory, the capacity and speed of the external memory, the structure of the programs and the dynamic characteristics of their functioning, one or another method of realizing relocated programs can be selected that guarantees an optimum ratio between the capacity of the occupied memory, productivity and cost of developing the programs.

Let us note in conclusion that the considered methods of realizing program relocation were used in development of the operating system for the Elektronika K1-10 microcomputer, whose composition includes a debugger designed for automation of the user program debugging process. With regard to the fact that the debugger is placed at the end of the main memory to make available a continuous address field to the user regardless of memory capacity contained in the set of a specific modification of microcomputers, it should be a relocatable program. The specifics of debugging includes execution of one or another procedures during execution of each instruction of the program to be debugged.

The requirement of operational debugging determined selection of the method of relocating a given program--correction of the absolute instruction addresses. A loader that operates with relocation dictionary is used to load the debugger. For conveience of utilization, the loader is realized a self-relocated program loaded in any free section of the memory. The operating time of the loader

is not a critical parameter and the means of correcting the addresses are found in the loader and may not be used; therefore the loader itself is realized by means of the considered macroinstructions by the second method of base control.

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PROBLEM-ORIENTED DEVICES AND PRODUCTION PROCESS CONTROL LANGUAGE STRUCTURES

Kiev UPRAVLYAYUSHCHIYE SISTEMY I MASHINY in Russian No 3, May-Jun 82 (manuscript received 18 May 81, after revision 7 Sep 81) pp 72-76

[Excerpts from article by senior scientific associate Tat'yana Nikolayevna Yegorova and Candidate of Technical Sciences Yuriy Nikolayevich Kotel'nikov, Moscow]

[Excerpts] Introduct. KAUT-80 (Verification, analysis and control of technology, implemented in 1980) problem-oriented language was created mainly to describe the modes of controlling vacuum production processes located at enterprises of the electronics industry. Vacuum production processes have response on the order of seconds and the absence of complex computer functions and a large variety of control strategies are typical for them. Conversion from control minicomputers to microcomputers and microprocessors require the development of a new programming automation system (SAP) on the basis of a high-level input language. It is known that the use of a special language not over loaded with surplus devices enhances the effectiveness of applied programs and considerably reduces expenditures for production of them. Moreover, the simplicity and problem orientation of the language permit the recruitment of specialist-technicians have no skills of professional programming to development of control programs.

A large part of the properties of KAUT-80 language is typical for any sequential programming language [1]. This is natural since even complex control and operating systems consist of processes which in themselves are quite sequential. KAUT-80 contains a sufficient set of designs that guarantee calculations and program control, including control transfer, condition and cycle operators and also a set of specialized devices required to describe the process of real-time control of the production facility.

KAUT-80 problem-oriented language has the following properties:

--the initial program is an easily readable text in Russian language. The names introduced by the programmer are not limited in length and may reflect the physical meaning of the variable being described;

--the numbers with which the program operates can be represented not only in octal and decimal number systems, but in volts as well, which facilitates

working with actuating components and sensors installed on the control facility;

--description of equipment (sensors and actuating components) is reduced to naming the communications channels between the production facility and the control microcomputer, which relieves the input language of inconvenient and cumbersome means of describing external devices;

--the modular principle, which includes separation of the initial problem into specific constituent parts, is used extensively. The production program contains the aggregate of descriptions of operations, each of which is programmed and debugged independently to a considerable degree and can be used in assembly of complete production programs;

--there are multiprogramming devices that permit one to control parallel and asynchronous completion of the required number of operations;

--the language structures are simple and single-valued. The names of the operators take into account the specifics of describing the production processes.

The experience of using the KAUT language developed by the same collective at the beginning of the 1970s [4] for group control of facilities and oriented toward minicomputers was taken into account in developing the new language. Those deficiencies of KAUT language such as lack of development of means of changing the method of control, the rigid restriction of the number of operations performed in parallel and the considerable laboriousness of accompaniment and correction of applied programs have been eliminated in KAUT-80 language. Main attention was devoted in development of the problem-oriented high-level language to problems of reliability, specifically, the uniqueness of the language structures, simplicity and accessibility of its exploitation by a rather wide range of specialists in ASUTP [Automated production process control system]. The main advantage of KAUT-80 language, which distinguishes it from known Soviet process control languages [4-6], consists in the capability of modular design of production programs. The modular principle of the language simplifies the programming technology, permits one to develop and accumulate a library of applied program modules, upon accumulation of which programming of production processes can be reduced to writing "linking" operations that guarantee interaction of typical production operations.

KAUT-80 language is included in the programming automation system of the same name [7], which includes the following components:

--a one-way compiler that generates the real code of the Elektronika-60 control microcomputer in dialogue mode. The compiler automatically formulates the operations and functions in the form of independent modules supplied with the necessary information for cmmunication with other modules of the KAUT program.;

--a composer that combines individual modules into a unified control program;

--an operating system that guarantees real-time fulfillment of the control program at the control facility.

All components of the KAUT-80 SAP are realized on the Elektronika-60 control microcomputer with memory capacity of 8K 16-digit words.

A number of production process control programs for manufacture and aging of electrovacuum devices and various types of etching and spraying processes distributed throughout the electronics industry has been developed in KAUT-80 language. The volume of applied programs produced by using the KAUT-80 SAP comprises approximately 2K 16-digit words of read-only memory and 2K 16-digit words of main memory for the variable file.

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REALIZATION OF SUBSET OF IML LANGUAGE FOR ICAM-10 AUTONOMOUS CRATE CONTROLLER

Novosibirsk AVTOMETRIYA in Russian No 2, Mar-Apr 82 (manuscript received 10 Apr 80, revised version received 2 Dec 80) pp 83-85

[Article by M. N. Bukharov, V. M. Vukolikov and Ye. V. Pankrats, Moscow]

[Excerpts] Introduction. One of the important methods of accelerating the development of experiment automation systems based on CAMAC equipment is the use of standardized programming languages, which permits not only a reduction of the periods of preparing the software of these systems but also guarantees independence of the developed programs of the types of crate controllers used. According to this, the ESONE Committee worked out and standardized several levels of software to control the CAMAC equipment. Realization of the subset of one of these languages--intermediate level CAMAC-language IML [1, 2] for the ICAM-10 autonomous crate controller [3] designed on the basis of the INTEL-8080 microprocessor, is described in the article.

Programming of CAMAC instructions for the INTEL-8080 microprocessor. The ICAM-10 autonomous crate controller is structurally made in the form of a CAMAC module with built-in INTEL-8080 microprocessor. A description of the controller is presented in [3].

Let us consider in more detail the operating principle of the CAMAC page. The CAMAC page is 1 K 24-digit words. The addresses of these memory words are virtual with respect to the microprocessor and are used only to start the CAMAC cycle for data transmission between the CAMAC page and the module registers. The microprocessor has access to each of three bytes of the 24-digit word of the CAMAC page.

The addresses of the module registers in the crate and the CAMAC function form the virtual CAMAC-memory with C000-FFFF addresses.

The ICAM-10 autonomous controller has eight interrupt levels: four CAMAC-levels and four systems levels. The interrupts can be masked by using a common mask, an individual mask to each interrupt level and CAMAC instructions for masking L-signals.

Programming of CAMAC instructions in the ICAM-10 autonomous controller reduces to use of standard instructions of the INTEL-8080 microprocessor, transmitted to the special virtual memory.

Conclusions. The use of the subset of IML language described above facilitates writing and debugging of programs and their use by other programmers, which permits a reduction of the period of designing the software for control of CAMAC equipment. It must be noted that creation of IML language for Soviet autonomous controllers, designed on the basis of the K580 microprocessor set, is considerably facilitated if one uses the described realization.

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CYBERNETICS, COMPUTERS AND AUTOMATION TECHNOLOGY

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 [III - USSR - 21C S&T]

GENERAL

IMPROVEMENT OF INFORMATION COMPUTER CENTER EFFICIENCY

Moscow EKONOMICHESKAYA GAZETA in Russian No 31, Jul 82 p 15

[Article by Yu. Dvornichenko, Department Head of Multiple-User Information Computer Center, Oblast Services Administration: "Provide a Full Load to Computers"]

[Text] The operation of the information computer center is judged differently. Some place the main point on such an indicator as the computer load (the number of operating hours of the computer per day), some judge it by the number of problems solved and others talk about the saving or about the volume of work performed. Thus, the main indicators of information computer center operation engaged in cost accounting are the computer load and the volume of work. Moreover, the second indicator is constantly a direct function of the first: the more hours the computer operated, the greater the profits of the IVTs [information computer center].

In this case no one is interested how the computer load is achieved and in the methods used to solve problems. Moreover, far from efficient operation of the computer is hidden behind such planned loading. And regardless of how paradoxical it seems, it is the main hindrance to conversion of information computer centers to multiprogram modes of computer operation and this means more effient use of its capabilities.

Are cost-accounting information computer centers, having a planned load, interested in reducing the problem-solving time on the computer? Of course not. To reduce the time of solving a problem, for example, by one half means to receive one half the monies from the customer for whom the problem is being solved and accordingly this means a decrease of profits. On the contrary, an attempt is made at this information computer center to "draw out" solution of problems in time and "to run" them in circles so as to overfulfill the loading plan.

How then are the collectives of information computer centers, located both on the budget of the enterprise and in cost accounting, to be stimulated and how is an expensive and high-speed computer to be operated more efficiently and rationally with maximum return?

I feel that the problem will be solved if the "load" indicator is replaced with the indicator of "coefficient of carrying capacity." It can be calculated by the ratio of the problem-solving time on the computer (in hours) to the saving from introduction of the problem (in thousands of rubles). The lower the coefficient of carrying capacity, the more efficiently the problem is solved on the computer in time.

The general coefficient of computer carrying capacity in this case will be equal to the ratio of the total time of solving all problems at the information computer center to the total saving. A decrese of the total coefficient of carrying capacity with a more intensive increase of the number of problems solved should become the most important condition for increasing the work productivity of the information computer center and efficient use of the computer capabilities.

Replacing the "load" indicator by the "coefficient of carrying capacity" indicator will obligate the collectives of the information computer center to reduce the costs of a machine-hour and to reduce the time of solving each problem.

6521
CSO: 1863/338

MAKING COMPUTERS INTERFERENCE-FREE REPORTED

Vilnius SOVETSKAYA LITVA in Russian 26 May 82 p 4

[Article by Yu. Stroganov: "To Make Computers Trouble-Free"]

[Text] It would seem that the developers of computer equipment have provided everything for dependable operation of their children. They tested the machines with vibrations and impacts, heat and cold and determined the conditions under which computers are supposed to operate reliably. And still there are frequent cases when a malfunction unexpectedly occurs in their operation.

The secret of the "misbehavior" was simple. This was due to accumulation of static electricity on the operator.

Scientists of the special design office (SKB) of the Vilnius Production Association Sigma explained that this is far from the only "caprice" of this type in computers. Computers also respond to changes occurring in the electric power supply system, to pulsed electromagnetic fields and to the emissions of other equipment. In order to make the machines less susceptible to interference, the causes of malfunctions had to be studied and classified. The interference had to be simulated so as to test the computer for reliability and to adopt measures for stable operation of them.

A group of authors--department head, Candidate of Technical Sciences I. Gurvich, chief project designer, Candidate of Technical Sciences B. Korneyev and the leading designers K. A. Vencius and V. Samuitis--developed the corresponding measuring and simulation devices and classified interference and as a result taught the machines how to control it. The complex of investigations conducted by the Vilnius scientists received high marks at the institutes of the USSR Academy of Sciences--the Institute of Precision Mechanics and Computer Technology and the Institute of Control Problems.

Colleagues of the SKB also worked out methodical materials in which a method is provided for protecting computers of the SM series against interference and emissions. The importance of the group's activity is indicated by the following facts. A few days ago these materials were sent to CEMA countries who produce computers of the SM series: to Poland, Bulgaria, Hungary, the CSSR, Rumania and to Cuba. And the entire cycle of investigations conducted by the Vilnius scientists under the title "Guaranteeing the Electromagnetic Compatibility of Computers" (1968-1980) has been presented for the title of State Prize of the Lithuanian SSR in the field of science and technology.

6521
CSO: 1863/234

COMPUTER TIME OFFERED TO USERS

Moscow TRUD in Russian 17 Jul 82 p 2

[Article: "Machine Time Made Available"]

[Text] The problem article published in TRUD, 13 April 1982, was titled "Machine Time Offered." It was discussed in it that the capacities of many computer centers are not fully utilized and expensive equipment stands idle.

The chief of department of computer technology of USSR Gosplan R. Ashastin and the chief of the Main Administration of Computer Equipment and Control Systems, GKNT [State Committee for Science and Technology], V. Myasnikov answered the editors. The criticism advanced in the newspaper was recognized as correct. The corresponding recommendations have been prepared for further improvement of computer utilization. It was provided in them that, beginning next year, all the activity of computer centers throughout the ministries and agencies of the USSR and Councils of Ministers of the Union Republics will be planned as an individual type of work.

The USSR TsSU [Central Statistical Administration] has been entrusted with creating an All-Union Association for Information and Computer Servicing. Beginning this year, seven territorial collective-use computer centers based on the VTs [computer center] for state statistics, will be developed. A procedure will be established by which computer centers and similar organizations for information and computer servicing will be created only through coordination with USSR Gosplan and USSR TsSU. These measures will permit the creation of new computer centers to be monitored and will increase the operating efficiency of existing centers and organizations.

The chairman of GKNT G. I. Marchuk decided to hear the question of increasing the utilization efficiency of computer equipment in Moscow during the third quarter of 1982 at a meeting of the board of the USSR State Committee for Science and Technology.

6521
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EFFICIENCY OF COMPUTER USE QUESTIONED

Tallinn SOVETSKAYA ESTONIYA in Russian 8 Jul 82 p 3

[Article by I. Gudim, head of operational dispatcher department, Republic Collective-Use Computer Center, Estonian SSR Central Statistical Administration: "With a Profit or Loss"]

[Excerpts] The YeS-1022 models (the smallest of the computers of this type in the capability of using unified software) of the unified computer system costs 500,000 rubles together with the supplementary equipment, without which it cannot operate. We note that this computer does not have devices for combining into a complex and for intermachine exchange of information (the "old" models having these devices are considerably more expensive). Several tens of square meters of production area equipped with devices for automatic maintenance of the necessary temperature and humidity and cleaning of the air to a content of 350 dust particles measuring no more than half a micron per liter are required for the YeS-1022. That is, conditions of the assembly shops for production of radio tubes or transistors and better cleanliness than a surgical operating room must be created. Otherwise the external memory devices of the computers with their magnetic disks and tapes, like some units that require stable temperature conditions, will break down during operation and the machine will be rejected. In other words, construction of computer centers and of auxiliary rooms in a hurry does not guarantee stable operation.

The computers of the unified system should be serviced in three shifts by not less than 40 highly qualified programmer specialists, electronic engineers and operators. One cannot get along without workers involved in transfer of documents written by human hand to punch cards, perforated tape, magnetic tapes and disks on special machines: the computer can "read" the information only by using them. There are also the administrative apparatus, suppliers, sanitary engineers, electricians, cleaning women (an especially important figure near the "clean area" of a computer) and so on. It is natural that this collective should work with a full return and should provide a profit on the most complex and expensive equipment. "Economics should be economical." This phrase became the catchword after the 26th CPSU Congress. However, only every fourth of the computer centers (subdivisions operating computers) existing in the republic is on a cost-accounting basis with independent budget. According to accounting data, only 10 computer centers among the cost-accounting centers had a profit in 1979, while the remaining ones had a loss of 989,700 rubles to the national economy. Six cost-accounting computer centers had a profit in 1980 and the remaining centers also operated at a loss.

How did this happen? Are the enormous losses inevitable? Analysis of the use of computers in the republic shows that, together with specific success in conversion of engineering and technical calculations and accounting work to computers (the volumes of this work doubled during the period 1975-1980), there are very significant deficiencies. And this is primarily due to the fact that narrow agency interests predominate over general state interests and there is also no propert coordination in organization of computer centers.

It is very simple to obtain a computer: it is sufficient to present a request to a superior organization. Computers have become the object of prestige consumption. The presence of a computer gives "solidity" to an enterprise or to an institution and indicates a "modern" style of management, although the real indicator of th modern style of management should be the economic and social feasibility of implemented organizational and technical measures.

The decree of the Estonian SSR Council of Ministers "On introduction of computer equipment into the national economy of the Estonian SSR and development of automated control systems" was published as early as January 1971. The decree obligated 14 ministries and agencies of the republic mainly to make use of the services of the computer centers of the Estonian SSR TsSU [Central Statistical Administration]. The computer system of TsSU was developed at that time and had its own enterprises with experience in servicing organizations of different sectors at 12 rayon centers and in the capital of the republic. Thus, fulfillment of the decree with fractional participation of the ministries and agencies in development of this network more than 10 years ago laid the bases for more effective use--collective use of computer equipment.

Now 13 of the ministries and agencies named in the decree have their own computer centers and some of them are developing their own agency computer networks! I repeat, this situation was created not because the technical base of the computer system of TsSU was unable to meet the needs for information processing with the intensive development. Narrow agency interests one. Development of computer equipment in the republic proceeded by a sharp increase of the number of new computer centers and installed computers. Naturally, the intensive growth of the numbers of personnel and administrative-management apparatus accompanies this. A total of 73 percent of all computer centers and more than 74 percent of computers existing in the republic is concentrated in Tallinn. The total number of computers increased twofold and the number of computer centers increased 1.5-fold during the 10th Five-Year Plan. The number of computer center personnel doubled during this time and the administrative-management apparatus comprises almost one-fifth of it. There is also another characteristic detail: the computer capacities (number of operations performed by a computer per second) increased by 19 percent in Tallinn during 1981 alone. And this load (calculated in operating hours per day) remained at the same level during the entire 10th Five-Year Plan and comprised only 60 percent of the minimum norm. And the main reason for this is creation of small local computer centers with physically obsolete stock of computers and idle times of computers due to an absence of work. Last year the idle times for this reason comprised 4 percent of the total useful machine time and increased almost 1.5-fold since 1980 (useful machine time is the time

paid for operation of a computer. The cost of one machine-hour of a YeS computer is an average of 100 rubles). And the idle times during the year increased by an average of 14 percent for the latest and most powerful YeS computers.

More idle times also occurred due to technical malfunctions (by 9 percent). This indicates that the Tallinn Scientific Production Center of the Association Algoritm is still not completely coping with its main task--complex centalized technical maintenance of computers.

One of the serious deficiencies in use of computers is dispersion of labor resources in low-capacity computer centers, due to which a seeming ever increasing shortage of qualified programmers and electronic engineers appears. They are being converted to administrative-management personnel with organization of new computer centers and the number of workers without a higher education with a specialty will increase at the computer center. Interest in collective use of computer equipment decreases with development of local computer centers, while it is conversion to collective use of computers that is one of the basic directions of development of the national economy during the 10th and 11th five-year plans. But the agency position is unsupported. For example, the Estonian SSR Gosplan and TsSU, having reviewed the materials for substantiation of the need of the Estonian Scientific Research Institute of Animal Husbandry and Veterinary Science and of the Estonian SSR Minzhilkomkhoz [Ministry of Housing and Communal Services] for computers recognize that it was unfeasible to create computer centers at these organizations. However, last year both Minzhilkomkhoz and the institute received new machines. The Scientific Research Institute of the Estonian SSR Gosstroy also receives computers without coordination with the Estonian SSR TsSU.

Let us recall in this regard what happens when concern for conservation of state funds is disregarded in favor of agency ambitions. The ASU department of the administration of the fish industry of the republic numbers nine persons with annual wage fund of more than 15,000 rubles and two of them are involved directly in development of algorithms and programs. The Minsk-22 computer registered to it (the load of the computer in 1981 was only 3.1 hours per day) was leased to the kolkhoz Lyanene Kalur. The kolkhoz did not assimilate the machine and leases machine time from the computer center of the Estonian SSR Minavtoshosdor [Ministry of Motor Transport and Highways]. The Uprrybkhoz [Administration of the Fishing Industry] itself leases 180 hours of machine time annually from the computer center of the Estonian SSR Minzag [Ministry of Procurement] (which has a computer underloaded in operation) and counts how many cans are filled. However, it is planned during the current five-year plant to receive an additional two general-purpose computer complexes (minicomputers) and to further increase the number of personnel.

There is also a computer oriented toward the software of the unified system at the computer center of Estrybprom at Tallinn. Its load in 1981 comprised only 6.3 hours per day (canned goods were also counted among the miscellaneous tasks). What keeps the two adjacent ASU on the technical base of the computer center of Estrybprom from being combined?

The Estonian Republic offices of USSR Gosbank and USSR Stroybank, each at its own computer center, process information essentially of the same banking operations. The computer load at the computer center of the ERK [Estonian Republic Office] of Stroybank was less than the norm last year. However, this computer center leases five hours of machine time daily on the side. The administrative and management personnel comprise approximately half the staff here. Nevertheless, it is planned to further increase the personnel and stock of computers during the five-year plan. The computer center of ERK of Gosbank, which also has considerable personnel with an impressive annual wage fund, plans to increase it by an additional 74 persons during the five-year plan and to obtain new computer equipment.

Machine time at the computer center of the Estonian SSR Minfin [Ministry of Finance] is leased from the computer center of the Estonian SSR Gosplan. In this case its own computers were underloaded last year and it is typical that 93 percent of the machine time was occupied with processing state insurance information, which was successfully processed by the republic collective-use computer center of the Estonian SSR TsSU prior to organization of this computer center.

A centralized ASU of finance and credit bodies is now being developed. If all the technical capabilities are utilized, they will more than support the calculations of Minfin itself and the republic offices of Gosbank and Stroybank. A multiple-user regional computer center will be achieved.

But let us take such an area as science. The Institute of Cybernetics, Estonian SSR Academy of Sciences, has the republic's largest YeS-1052 computer and part of the El'brus-1 computer complex has already been received. The YeS-1052, which can be loaded not less than 20 hours per day, had a daily "shortfall" of almost nine hours last year. Why then do four other academic institutes located in Tallinn have their own computers? All their needs could be provided by the computer center. It is not understandable how the Institute of Economics of the Estonian SSR Academy of Sciences, for example, did not make a similar suggestion. Incidentally, it also has a computer center where only a little more than half of 32 persons have a higher education and five of them are also not working in their specialty. The problems being solved here on computers (not scientific problems, but the task of how to account for materials and wages for enterprises and leasing of machine time to the Estonian SSR Gosplan) required more than a third of the machine time in 1981 and the computer load comprised 65 percent of the planned load. What can one say! And after all, according to economic indicators, the computer center of the Institute of Economics is supposed to be a model for others.

How can one explain, for example, the reason for the existence of two computer centers on the territory of the Tallinn Commercial Maritime Port--its own and that of the Estonian Maritime Shipping Company equipped with identical computers and even solving problems of the unified project of OASU [Automated Sector Control System] of USSR Minmorflot [Ministry of the Maritime Fleet]? Apparently, this is also because of agency "prestige." Combining these two computer centers can only be beneficial and can provide a considerable conservatio of funds.

The TPO Punane RET already mentioned was a user of the collective-use computer center of the republic TsSU and was successfully serviced with a computer remotely through the equipment of user stations. And even so envy developed here: the association broke the agreement and created its own computer center with a staff of 60 persons and plans to add and additional 35 to them during the five-year plan, to obtain another computer and so on.

What measures are required for efficient use of scarce personnel and for increasing the level of work in use of computers? They are quite obvious from the foregoing. But we still assume it necessary to emphasize that establishment of strict control over an increase of the utilization efficiency of automated control systems and computer equipment in the republic will help matters. The subdivisions of ASU not having computer time for the given moment should be attached to existing computer centers of their own sectors with underloaded computers. Coordination of the use of computer equipment should be intensified and transfer of computer operations from obsolete computers to new ones should be accelerated. And finally the notorious agency barriers should be broken. Low-capacity computer centers should either be combined during 1982 on the territorial principle or on the line of agencies solving complex programs. The freed equipment can be transferred to those republics where there is a real need for it. Each computer center should become a cost-accounting center and should show a profit.

The industry of our country has quite stably assimilated the production of information teleprocessing equipment. The elimination of low-capacity independent computer centers on this technical base and organization of multiple-user computer centers based on them will permit a qualitative rise in the level of information processing in all sectors and will result in implementation of the tasks posed by the 26th CPSU Congress: "Increase the quality and efficiency of management labor. Guarantee further development and an increase of the efficiency of the network of automated control systems and collective-use computer centers."

6521

CSO: 1863/338

UNDERUTILIZATION OF AUTOMATED CONTROL SYSTEMS REPORTED

Moscow PRAVDA in Russian 23 Aug 82 p 2

[Article by Candidate of Technical Sciences O. Gromyko: "Why Are Automated Control Systems Operating at Half Effort?"]

[Text] I recently visited a plant where 10 years ago we turned over one of the first automated enterprise management systems in the sector. It permitted one to calculate a detailed plan of shops for the month and the need for basic resources and to maintain operational accounting of the course of production. As a result, "lack of completion" was reduced by a factor of two and the rhythm of shop operation was increased. We had a total of seven developers armed with a single Minsk-22 computer.

Now there are approximately 100 developers plus operators in the ASU department, four modern computers are operating and display equipment and the SIOD-3 data base control system have been assimilated. What new things has the powerful computer complex brought to the managers of the services, shops, sections, planners and economists? It turned out that little has changed here.

Unfortunately, ASU with small expenditures on them rather frequently do not bring an improvement in enterprise management and the saving from them remains conditional.

What is the main cause here? During the past few years the capabilities of computer equipment have incrased significantly. The cost of one hour of operation of large machines has also increased. But as before, routine problems of the same class as before are frequently solved by using them and nothing is said about optimization of planning and analysis of production and economic activity using computers. A gap has formed between the capabilities of the computer and the low level of many ASU.

The fact is that their development and introduction, which were initially thought of as a temporary phenomenon (let us design, introduce and work at a new qualitative level!), were transformed into a permanent process of design, finishing and development of control systems. It was calculated in one of the sectors that the expenditures for design of an ASU became a permanent expense item of many enterprises and comprise 100,000-150,000 rubles annually.

This occurs primarily due to the fact that each enterprise and institution hardly develop an ASU independently. There are also costs from this: low efficiency, large expenditures, long design and introduction deadlines and "lack of coordination" of systems of different levels and agencies.

Database control systems and applied program packs have begun to be distributed during the past few years which helped to eliminate the named deficiencies. But introduction is occurring slowly. The fact is that it is difficult for the designer of any ASU to correctly select the appropriate database control system and applied program packs so that he has a poor idea of the system as a whole and moreover standard methods of tying in these devices to specific conditions have also not been worked out. Scientifically based and convenient information and algorithmic models have not been proposed for large, complex control entities.

I feel that one should begin with All-Union classification of control entities to be automated. Moreover, this should be done on the information-algorithmic principle when the community of algorithms and data structures is the basis rather than on the functional principle (ASU Pribor [Automated Management System for the Instrument Building Industry], ASU Gaz [expansion unknown] and so on).

There are not so many of these classes of entities. Database control systems and applied program packs should also be oriented toward them. The users also gain an advantage from this since they will have specific recommendations on selection of systems and the developer will have them since clear requirements will be given to him.

Development and introduction of modern data processing systems and methods of designing ASU are one of the timely problems of state significance. The head institutes involved in solution of it must allocate the necessary resources and financial means, sharply reduce design of nonstandard ASU and stop parallel development of ASU of the same type in different sectors--I feel that these are urgent measures.

But this is also not everything. In many cases the systems being developed do not have official customers, but the developers themselves assign the technical assignment to themselves. There are of course customer-users of the systems, which are the subdivisions of the enterprises and ministries. But their interests are frequently in contradiction with the requirements on the system as a whole. It is felt that regardless of who the designer is, there must be a special department, small but qualified, which will take on itself the obligations of customer of the ASU and will defend the interests of the organization for which it is being designed at all stages of development and introduction of the system.

The interests of the matter dictate the need to increase the requirements on the contract design, detail plans and the control systems themselves during acceptance by committees. The customer is frequently not sufficiently competent to influence the decisions selected by the developer in design of an ASU, while agency or state committees are incapable of making any c anges

during the stage of acceptance of systems. Why not introduce state inspection of the quality of ASU, for example, attached to the USSR State Committee for Science and Technology, and why not entrust it to check the scientific and technical level of systems being developed?

Much also depends on the place allocated to the computer center in management of an enterprise or institution. If it is limited to routine accounting functions, then introduction of an ASU will be very difficult. And on the other hand, if computer centers take on themselves part of the functions of planning and accounting, they become participants in management of production and the success of introduction of the ASU is guaranteed.

And finally, what about personnel. Who develops the ASU? One effective person is the so-called supplier of functional tasks and the other person is the programmer. The first knows a narrow sphere of production or economic work (for example, planning of and accounting for raw material and materials) and the second knows machine programs. But neither one nor the other knows the system as a whole. A third section of developers (and the first insignificance)--the architects of the system, who have a good knowledge of the structure of the information flows and the data processing algorithms in the system as a unified mechanism, is also needed. Personnel of this profile are only beginning to be assembled.

Many institutes that train specialists for ASU do not acquaint the students with the development of data banks--the basic progressive form of organization and processing of information. Specialists in the field of management and economics of the national economy frequently have very approximate data on the capabilities of today's computers. Moreover, abundant experience in training specialists of different applied profiles who have knowledge in the field of programming, organization and data processing using computers, has been accumulated at some institutes, specifically the Moscow Physicotechnical Institute. It is felt that their experience should be used more extensively at all engineering and economic vuzes. This is especially important with regard to the beginning of the phase of extensive use of minicomputers, which are becoming a consituent part of the engineer's workplace.

Automated control systems affect the broadest layers of workers of the national economy and impressive funds are expended on development of them. The interests of the matter require serious rearrangement of the organization of development and introduction of ASU.

6521
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PROBLEMS OF AUTOMATED CONTROL SYSTEM DEVELOPMENT

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA EKONOMICHESKAYA in Russian No 3, May-Jun 82 pp 82-91

[Excerpts from article by V.M. Katkov and V.A. Petrushanskiy]

[Excerpts] This article discusses increasing the efficiency of automated control systems by using an integrated systems approach to developing and implementing automatic control systems at associations and enterprises. The trends in automatic control system development, the influence of automating control on the management mechanism and the improvement of the entire enterprise management system based on economical-mathematical methods and computer facilities are examined on the basis of practical experience.

At the beginning of 1981, over 5,097 systems with various functions were in operation in various areas of the national economy, including 2,040 automated process control systems (PCS), 1380 automated production control systems and 279 branch information systems (BIS).

Automatic control system development is characterized by a continuous increase in the number of systems developed, reduced developmental periods, reduced cost and increased efficiency. For example, during the 9th Five-Year Plan the Scientific-Research Institute for Control Computers and Systems introduced 75 systems providing overall savings of 23 million rubles, and 114 systems in the 10th Five-Year Plan with savings of 84 million rubles. During the 9th Five-Year Plan the Scientific Research Institute for Automated Planning and Control Systems introduced 48 systems providing savings of 21 million rubles, and 108 systems during the 10th Five-Year Plan with savings of over 60 million rubles.

An automated production control system was put into operation in 1977 at the Volga Automobile Plant (AvtoVAZ) which carries out more than 200 tasks and includes more than 1200 programs. The annual savings provided by this system amount to 3.9 million rubles. In 1979 the "Aktyubrentgen" plant implemented and automated technical production preparation systems providing annual savings of 820,000 rubles.

In 1978, the "ASU-Minpribor" [Ministry of Instrument Building Management Information System] provided savings of 30 million rubles, and the "ASU - Mingazprom" [Ministry of the Gas Industry Management Information System] - 40 million rubles. The use of a management information system by Gossnab SSSR alone provided 70 million rubles of savings in 1978, including more than 40 million rubles saved in transportation expenses.

The overall payback period for the resources invested in control system development does not usually exceed 2.5 years for production control systems, 1.5 years for technological process control systems and 3 - 3.5 years for branch management information systems. Savings exceeding 10 billion rubles were achieved over a relatively short period (1966-1978) by introducing automatic control systems within the national economy.

The advantages of automatic control systems and their high efficiency are obvious. Nonetheless, they are still not fully utilized. Many systems which have been accepted by commission and which respond to all of the requirements of the technical specifications do not play the required role in increasing the functioning efficiency of the overall management system of the enterprise. The actual savings from introducing control systems often does not reach the calculated levels, and amounts to only 14-25 percent for a number of enterprises [2].

Research done at 20 enterprises which were calculated to have high efficiency after the introduction of an automatic control system indicated that the commodity output dropped at two enterprises, the proportion of the management apparatus within the overall number of workers increased at 10 enterprises, the cost per ruble of commodity output increased at eight enterprises, worker idle time increased at six enterprises, overtime work increased at eight enterprises and unproductive losses increased at eight enterprises [3].

Analogous difficulties are also observed abroad. Estimates by experts have indicated that of all of the computers installed in capitalist countries only 20 percent are utilized efficiently, 40 percent are profitable only at full load and 40 percent are not economically justified [4].

In this connection, studying the technical, economic and organizational conditions for developing and operating automatic control systems, and problems of increasing their actual effectiveness, take on first priority. Further development of automatic control systems requires a thorough foundation of the causes of divergence between the actual and calculated effectiveness of automatic control systems, the low influence of automatic control systems on improving the overall management system and determination of future directions.

Estimating the actual effectiveness of an automatic control system is a complicated problem, since many of the automated system factors which influence technical and economic production indicators cannot be measured precisely. Existing methods for determining economic effectiveness do not establish the relationships between the sources of savings and the nature of the problems solved by the automatic control system and the structure of the system, and do

not allow for system performance. These methods make it possible in principle to operate very arbitrarily with the components of the savings, and to obtain "effective" systems, without delving into them substantively, by "correctly" selecting and combining these components [5].

The qualitative influence of automating control on the management mechanism depends completely upon the theoretical and methodological foundation which is implemented when the system is developed and upon the level of organization of all of the work involved in automating control. We shall discuss below some of the resistant trends and problems in automatic control system development which in our opinion reduced the effectiveness of automating control.

The most important methodological principle in scientific investigation of production control is the principle of integrity. During the initial stages of automatic control system development, the question of the advisability of a particular computer application was reduced to the question of its technical realizability, so that it became the responsibility of computer equipment specialists to provide the answer. Computer hardware, software and automated control systems themselves have undergone substantial development since then. Although under present conditions the technical realizability of an automated control system plan, together with the organizational, economic and technological support of automated control processes, technical specialists still have priority in determining the development and utilization of automated control systems and making management decisions. For this reason, questions involved in developing an automated control system are often pushed aside in favor of developing machine technology for processing production data in isolation from the overall problem of improving the management system. The algorithms employed by automatic control system developers reflect the traditional forms and methods of management which, having been held for a long time, make the existing system more conservative. Problems are mostly stated on the basis of the experience of the developer and the capabilities of the computer hardware rather than thorough scientific analysis of the entire production control system. For this reason, many important control tasks remain beyond the scope of the automated control system.

A one-sided view toward hardware and mathematical methods in improving management leads to excessive "technicality", which in turn brings about such negative phenomena as retaining traditional accounting and reporting forms, approaching the substantive aspects of control processes superficially, underestimating the role of management methods and complicating the interaction between organizations and subdivisions within the enterprise. The main goal of automation - increasing the effectiveness of the management system - is not achieved.

The question arises of the level of effectiveness which can be expected from automated control systems under these conditions. The automated control system is supposed to automate and optimize processes. If management processes are automated, their effectiveness cannot exceed the effectiveness of the management method itself. For example, if a system is intended to prepare and process planning-statistical and normative-reference documents, to handle bookkeeping, to compute payroll, etc., the savings are expressed only in

reduced labor for carrying out individual management functions. The introduction of automated planning and accounting for technological preparation of production based on network models, for example, is another matter entirely. In this case the entire process of preparing and assimilating an article is divided into stages, phases and operations in a straight logical sequence; tasks are planned in parallel and optimized in the network model everywhere possible. This produces significant savings, primarily through the use of new planning and management principles and qualitatively new approaches. The source of the savings in this case includes the management sphere as well as that of material production, since it is there that the new management decisions are directly implemented. The implementation time can be cut in half simply by executing tasks in parallel, i.e., disregarding the effect of automating and optimizing calculations. The effectiveness of an automated control system thus depends upon the effectiveness of the management methods. The method used to calculate the effectiveness of automatic control systems fails to connect these two important facets, which explains the significant divergence between the actual and calculated effectiveness figures. Anytime the development of an automated control system is based on existing traditional management methods, whose reserves have already been basically exhausted, the system effectiveness cannot be high. In addition, not enough significance is ascribed to the management methods and their organizational form in developing and implementing different types of automatic control systems. As a result, the systems, without touching upon the essence and management principles of organizational structures, automate only individual processes, engendering disproportions in labor productivity and the occurrence of bottlenecks, with all of the attendant consequences: complication of the implementation process, the appearance of psychological barriers and reduced economic effectiveness of the system.

The experience of the Volga Automobile Plant indicates that the management technique and the manner in which automated control systems are used are elements in organizing production management which must be tied into a unified system with the organizational structure, processes, information, methods and personnel. Experience has shown that without this integrated approach even the use of the most sophisticated computer facilities is ineffective [6].

Academician V.M. Glushkov notes that "the automated control system, of course, is not an end in itself. The ASU is an automated system, not an automatic one. The main thing is not the hardware itself, but rather the organizational aspects, which have not become especially clear" [7].

An integrated systems approach to automated control system development requires that both the economic-mathematical methods and hardware must be looked at as organic parts of a whole. However, this approach still has not been implemented widely because of the methodological and organizational insufficiencies in developing and implementing automatic control systems.

The Branch Methodological Guidance Materials for automated control system development reduces the organizational support process to analyzing the existing control system in order to provide a statement of the problems of automation [8]. The results of the organizational investigation are documented in the

statement of the complex of problems. The cost of pre-plan investigation together with development of the technical assignment does not exceed 2-5 percent of the cost of the planning work [5].

This arrangement of affairs makes it possible to single out, while investigating the enterprise, stable production processes involving routine repetitious operations and calculation, which can be automated but do not provide the capability for a thorough scientific analysis of the entire enterprise management system or to note ways of improving it - the organizational process itself is aimed toward automating only individual local control processes. The Branch Guidance Materials do not pose the question of integrated improvement of the management system, and contain no provisions for documentation in which it might be reflected.

In our view, the goal of the pre-planning stage of an automated control system must be to create conditions for improving the enterprise management system on the basis of economical and mathematical methods and computer facilities; this process must start with the creation of new management principles, methods and forms on which the automation is based. Besides singling out reserve capabilities in control and production, the integrated investigation of the existing system must also try to find new organizational forms of production and control in order to implement a management mechanism which is built on a modern technical base.

Automation of administrative processes must be based on a thorough scientific understanding of management processes and extensive study of advanced production experience. Substantial research must be done on management organization, technology and methods, employing highly qualified specialists in this area, only then introducing automation on the basis of their findings.

Analysis of the organizational structures and composition of specialized scientific-research institutes and design organizations which develop and introduce automated control systems leads us to conclude that these organizations are not sufficiently prepared to solve these problems. No more than 30-35 percent of all of the workers within an organization are usually included in setting up tasks, and this figure is tending to become smaller. Many of the specialists among those who are involved have no practical experience in management work at enterprises: they work in integrated departments together with programmers, and are often under their direct supervision. Many large scientific-research institutes engaged in automated control system development lack research departments for management organization, technology and methods. This is why most automated control systems are implemented without a thoroughgoing organizational and methodological preparation of the enterprise for a fundamental restructuring of the management system.

The work involved in developing and implementing automated control systems within associations and at enterprises is also not aimed towards solving the fundamental problems of improving the management system. According to the Branch Guidance Materials, the automated control system department (computer center) is recommended as the authority to arrange for preparing the enterprise to implement the system, to participate specifically in the developments and

to monitor their progress, as well as the application and reliable functioning of the system.

Nonetheless, working out questions of the functioning, development and improvement of the management system and methods is the direct function and responsibility of the leadership of the association or management of the enterprise under the supervision of the director [9]. For this reason, the automated control system department is involved in practice primarily with automating existing management methods which do not involve fundamental questions of the organizational structure of the association or the principles used to manage it. However, as we mentioned above, the effectiveness of these systems is not very good. Experience shows that conscious acceptance by the top-level supervisor of the task of creating an automated control system is the deciding factor in its successful accomplishment [10].

Given this, how do we explain the need for an automated control system department, and what are its goals and functions? The implementation of an automated control system assumes specialization and centralization of data processing and ordering of data streams. In our opinion, the goal of automated control system activity is therefore to improve the information support of the management system and of design work. As a result of this primary goal, the automated control system department is responsible for improving management methods involved in the ordering of information processes; participating in system development and implementation; automating processes involved in data processing; developing algorithms and software programs; operating equipment and certain parts of the system, etc.

Concentrating the efforts of the automated control system department on solving the problem of management system information support changes the nature of the work of the department. Information support is now provided on the basis of the specific requirement of the functional tasks of the automated control system. For this reason, different systems build up different data bases at the same enterprise. Information is often duplicated for different ASU control systems. This leads to overlapping of information, which makes it much harder to update and correct. Information overlap is also observed between the automated and unautomated sections of a management system. This variety of sources results in an overall increase in the amount of information, makes it more difficult to manage and use and generates contradictions in management methods.

Under the present new conditions, information support is provided on the basis of rational functioning of the entire management system, since the contro system department is specialized to handle data processing in the associ ion. Improving information processes is the most difficult measure involved rationalizing management systems, and must be done in close connection ı those processes. The use of computers requires new information support methods: there are now three basic ways of improving information support:

1. Redistributing the amount of information work among production management levels, with larger volumes of work being transferred to lower and line units.

2. Employing the methods of economic informatics to improve the actual information support of a management system.

3. Mechanizing and automating information processes by using new equipment and computers.

The greatest success is achieved when all of these methods are used to improve information support. As we can see, two of these do not involve computers. For this reason, work on improving information support can and must begin before work starts on the automated control system. Consequently, the creation of an independent information department in a modern data-intensive production facility should not be associated rigidly with automated control system development. At the same time, the improvement of information support cannot be limited to questions of mechanizing and automating processes, which is sometimes the case during ASU development.

As an example, some ASU developers who have high-efficiency data processing equipment available send huge amounts of information to their supervisors, considering this to be an advantage of the system. In fact, however, this uneconomical dissemination of information, regardless of its timely production, makes the management process more difficult and complicated. In a different case, by using the deviation management principle in which a plan serves as the permanent information carrier, while current information consists of deviations from the plan, specialists at the Scientific-Research Institute of the USSR Central Statistical Directorate to reduce the amount of data transmitted by a factor of 16.6 in the branch current reporting system, with practically no reduction in the level of informedness of management. The cost of data transmission using the deviation method was approximately 7-8 percent of the cost of forwarding daily reports [11].

These examples, demonstrating the lack of effectiveness of automation when implemented without justification and the effectiveness of employing the economic informatics method, show how important it is to ensure a scientific approach, rather than a one-sided one, to developing the information support for a production control system.

The lack of a unified conceptual theory of the development of automated control systems and of general universal principles for their construction results in different understandings of the purpose of automated control systems and of the methods used to develop and implement them. Every ministry has its own lead scientific-research institutes for developing and implementing automated control systems which are responsible for coordinating projects and providing methodological support. Many independent approaches to the problem of automating management processes have thus arisen, which in the absence of an overall theoretical perspective of ASU development has lead to wide dissemination of individual design methods. At the same time, the broad front of ASU projects has engendered parallelism, a low level of unification and poor scientific foundation for the design treatments used.

Many institutes are developing the same systems and tasks in which the differences are neither significant nor fundamental and result not from the employment

of different management methods but from different structure of the data bases, input and output information and differences in the processing algorithm. Lack of clarity in the classification composition of ASU, subsystems and tasks and types of documents makes the system development and implementation process more difficult.

The effectiveness of automated control systems is determined to a great extent by the completeness and quality of the software. The structure of expenditures for design work demonstrates a stable trend toward an increasing share for software. The number of mathematician-programmers at ASU scientific-research institutes and design organizations exceeds significantly the number of people involved in establishing tasks, and is tending to increase still further. About the same is the case for ASU departments at enterprises.

Since software development costs exceed the costs for duplicating, installation and checking on each series system by a factor of 100-1000, as the sizes of series of like control systems increase the relative cost of the software drops sharply. However, the flexibility of automated control systems and their software is low; an extremely large share belongs to unique systems. This is directly because of the organization of the systems development process itself.

To begin with, there is no clear delimitation between the individuals who establish the tasks and the software developers. The common opinion is that the system development process can be speeded up by having the programmers and requirements agent work together. We cannot agree with this, because the work of the requirements agent and the mathematician-programmer differs in principle, and while their final goals are the same, their organization requires a clear division of labor and allocation of responsibility.

Modern programming technology cannot be realized when programmers are grouped functionally in small subdivisions, which produce, slow, expensive hand-made planning. This results in multilevel duplication of expensive, laborious work, the absence of any legal or administrative responsibility for the development of individual components and the entire complex of programs during various design stages, to irregularity in setting up the process, with too little work at the beginning and overloads in the concluding stages, to incorrect distribution and loading of scientific and technical resources and to a low level of automation of technological processes in program design.

The goal of the requirements agent is to use economic principles, thorough scientific analysis of management systems and modern, progressive management methods to isolate stable elements of the overall management process, to determine methods for formalizing them and adapting them to different production conditions. The requirements agent must bear full responsibility for performance in developing the technical programming requirements and the level of requirements distribution.

Once programs are considered to have been debugged autonomously, between 10 and 30 errors per thousand instructions are discovered due to the lack of clear formalization of the technical requirements for program complexes and

their components. Each error requires changing an average of 15-20 instructions, so that the program complex becomes 30-40 percent larger [12] during integrated debugging and testing. Under these conditions, methods and means are needed to provide the developer with a single understanding of the characteristics of the complexes of programs to be developed.

Centralizing programmers into large specialized subdivisions makes it possible to coordinate programs which have similar functions and solution methods in order to reduce duplication significantly. In order to do this, it is necessary to have a classifier and unified catalog of developed and tested program modules and groups of applications programs. The appearance of a set of programs which serve to solve a particular class of problems and which are adapted to the specific requirements of the largest possible number of users characterizes the transition from manual to industrial production of software. The user cost of modular software is approximately 10 times less [4].

In order to develop industrial methods of implementing automated control systems, the Ministry of Instrument Building has formed the "Tsentrprogrammsistem" scientific-production association which now has more than 400 applications program packages which have been developed by organizations around the country. Considering that only 6 percent of all enterprises have automated control systems, the importance of extensive implementation and maintenance of applications software packages, permitting automated control systems to be copied at different enterprises around the country, becomes understandable.

Software maintenance practices reconfirm the need for an integrated systems approach to automated control system development and for increasing the role of organizational and methodological aspects in system duplication. It seems expedient for an organization which is created to produce finished software to concentrate scientific efforts on integrated improvement of the management mechanism, assuming the use of economic and mathematical methods, improving information support and employment of computers, creating standard organizational plans for automated management methods, preparing and adapting packages of applications programs and program modules for specific production conditions, i.e., concentrating on supporting the distribution process.

In practice, software maintenance consists of correcting and modifying software, the cost of which is 3-5 times greater than the cost of the materials and of copying and testing programs. The "Tsentrprogrammsistem" scientific production association includes a scientific-research institute for ASU software; however, as in many other research and design organizations, there are no research subdivisions to analyze management organization, technology and methods. The local development of automation in isolation from organizational and methodological management problems does not respond to modern conditions for improving production efficiency.

Socialist industry is faced in the 11th Five-Year Plan with new major, urgent problems which cannot be solved without a program for eliminating existing contradictions and singling out unpromising trends in ASU development, increasing their effectiveness and converting the economic management system to

an efficient facility. An automated control system assumes an integrated solution to the problem of increasing management effectiveness, since system implementation is not associated simply with the employment of computer facilities and the use of economical mathematical models, but also with the introduction of progressive changes to the existing organizational structure and management methods, rationalization and clear regulation of document flow and the creation of new standards, the improvement of production and labor, principles of management accounting, economic and moral incentives for workers, etc.

An automated control system will be effective if their development employs an integrated systems approach and if the goal of the implementation is not simply the functioning of the system as part of a plan but rather the improvement of the management system, if the automated control system replaces the traditional system, rather than working alongside it or in parallel with it, growing out of the traditional system gradually as conversion is done on the basis of a unified methodological principle, a fundamental redesign of the management system and a subsequent set of purposeful measures to restructure the existing system to an automated one.

For this reason, the implementation of an automated control system must be accompanied by organizational planning. Organizational plan development is used widely as the basis for preparing the implementing automated control systems in a number of industrial branches, e.g., at enterprises of the Ministry of Tractor and Agricultural Machine Building [13]. This increases system effectiveness significantly, with most of the increase, amounting to 80 percent, coming from organizational measures [14].

Work must be expanded on standardizing organizational management plans; research on urgent problems of organizational planning must be arranged, generalizing and disseminating them through all-union, branch and enterprise standards; it is advisable to expand and increase the qualitative level of organizational planning work allowing for the capabilities and requirements of automated control systems. The necessary conditions exist for creating design organizations or subdivisions to provide integrated designs for the organizational-economic part of the management mechanism, including automated data processing systems. The task is to make organizational planning an obligatory component part of the implementation of automated control systems at an enterprise, which should ensure industrial dissemination of applications program packages built using the modular principle.

The development and implementation of automated control systems must be based only on the very latest management methods. The automation process itself, because of its high degree of organization and productivity, brings a great deal which is new and progressive to the management process. The implementation of automated control systems demands the classification and coding of technical-economic information, ordering of information streams, the construction of information models, analysis, refinement and formalization of management tasks and the construction of a normative base. All of these areas are prerequisites for improving management methods and approaches.

The development of a classification and coding system makes it possible to convert technical and economic information to a form convenient for computer processing, as well as to order all information about the production medium, the production entities, the production relationships, to refine the nomenclature and interrelation between all elements of the production medium, to give it a quantitative estimate, i.e., to order and stabilize it, and in the future to obtain the capability of controlling it. The classification system opens up broad possibilities for such effective processes as unification, and grouping. It is important that these extend over the entire management system, and not just to individual processes which are subject to automation. The classification system requires unity of normative indicators, and can be used to solve problems of selecting the optimal production structure of a section, shop or plant, creates the prerequisites for improved series production of articles in small-series and series production, and supports the specialization of production, the introduction of production-line, mechanized and automated production processes [15].

The development and implementation of automated control systems should thus not be considered simply as a process of automating individual types of work, but as a qualitative jump in management methods and approaches. The correct choice of management methods making up the basis of this system is exceptionally important, since the level of effectiveness of the automated control system depends upon it.

Further improvement is needed in the way the process of ASU implementation is organized. The complex procedure of translating an existing management system to new organizational conditions and to new management methods with a qualitative change in the technical foundation of management processes cannot be reduced to filling and handing in technical documentation and organizing a computer center and ASU department. The entire management apparatus, under the direct supervision of the director, must participate in improving the management system.

In order for draft ASU treatments to be converted to an effective management means, they must be accompanied by organizational, economic and technological support. Organizational support assigns all procedures within the automated management process to specific subdivisions and executives and ensures that they are monitored and regulated. Economic support creates economic interest and a system for stimulating planned processes and projects. Technological support is aimed toward the development of the technology of automated management processes.

Explaining the principles of automation in the system technical documentation should be recognized as insufficient, since the draft documentation does not play an independent organizing role in improving management processes. The principles upon which ASU documentation is based represent only the potential capability of improving the enterprise management system. In order for developed principles to become real, they must be reflected in the organizational-directive, normative-technical and administrative documentation. Only then are the principles of automation transformed into a real management technology.

The new management tasks put forth by the present development of the Soviet economy require improvement in the methods by which ASU are implemented as well as a substantial deepening of automation processes. The solution to these problems depends to a great extent upon the degree to which the development of methodological foundations for creating and implementing ASU are directed toward the end goal of improving economic management processes.

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6900
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MICROELECTRONICS AND COOPERATION OF CEMA COUNTRIES

Moscow IZVESTIYA in Russian 12 Aug 82 p 5

[Article by Corresponding Member of USSR Academy of Sciences D. Zhimerin, First Deputy Chairman of USSR State Committee for Science and Technology]

[Text] Electronic equipment and the automated control systems developed on its basis have achieved impressive progress within a short time. The qualitative changes of electronic equipment have made it possible to use it in planning, control of individual units and production as a whole, in scientific research and in planning and design developments.

The development of electronic equipment in the Soviet Union began somewhat later than in some developed capitalist countries, but we have completely approached the worldwide level in quantitative and qualitative indicators in the sector as a result of vigorous measures adopted. As a result, practically all automated control systems (ASU) being developed in our country are equipped with Soviet computers and software. An exception are the peripheral devices produced in CEMA countries by intergovernment agreements or received with deliveries of equipment and complete sets.

Special success was achieved during the past few years in both the Soviet Union and abroad in microelectronics, which is the base for development of modern computers, peripheral devices and automation equipment. Successful development and organization of serial production of large and very large integrated circuits (BIS and SBIS), in which thousands of components are arranged on an area of several square millimeters, open new prospects in development, improvement and the use of computer equipment in all sectors of human activity.

New-generation computers having high speed of calculating operations, which number in tens and hundreds of millions of operations per second, are being developed on the basis of BIS and SBIS. In this case computers, by performing logic functions, free the programmer of need to detail the development of programs.

Microelectronics has opened real prospects for development of computers that "understand" or rather perceive and reproduce human speech. And this means that in the future this computer can operate by tasks assigned by voice.

The use of BIS and SBIS has made it possible to develop microcomputers and microprocessors. The difference of these devices from existing general-purpose or control computers consist in the fact that their dimensions and cost are reduced sharply, while comparatively high speed is retained. Thus, it became possible to design microcomputers which are capable of rather economical control not only of complex production processes or groups of interconnected units, but of individual machines, machine tools, etc. as well.

Microcomputers are of special importance in development of the production of robot manipulators in general and adaptive robots specifically. As is known, the delaying aspect of robotization was the fact that, without electronic control, robot manipulators could perform work only by a rigid program. Moreover, full automation and replacement of man during production required development of a robot capable of performing diverse labor operations. This adaptive robot was developed on the basis of microelectronics. This is a unique robot-"multimachine tool," which is capable of performing various functions by means of a microcomputer or microprocessor according to an established flexible program.

Devices for automatic control of many appliances, for example, electric burners and washing machines, were developed by using microprocessors; microprocessors can control injection of fuel into an automobile engine. Microprocessors are also used extensively in automatic telephone exchanges and equipment.

During the past few years, microelectronics has begun to be used with great efficiency in medicine as well. Thus, electric stimulators of heart rhythm, developed on the basis of integrated circuits an a miniature power source, save the life and control defects of the cardiac rhythm of thousands of people. Polyclinics will be equipped with diagnostic systems and automatic blood sampling and analysis systems based on the use of microcomputers during the next few years. The history of the state of health or medical history, entered in the computer memory, will permit the physician to retrieve all necessary data on a display screen within seconds.

The list of areas of human activity where microelectronics is already being used or may be used in the future is practically unlimited. Extensive introduction of microelectronics is now acquiring special timeliness during the 1980s when the increase of labor resources is slowing down and when the time requirement has become the fact that economics should be economical. However many obstacles and unresolved problems have been accumulated in the path of introduction of microelectronics. Among them should be distinguished the shortage of peripheral devices, software and also debugging and diagnostic equipment.

Combining the creative forces of the socialist countries in this area will make it possible to overcome the existing difficulties in production and use of microelectronics within short deadlines due to efficient use of the scientific and technical and production potential of the interested countries. Even more so since we CEMA countries already have many years of experience of this cooperation in the field of developing computer equipment.

In 1969 Bulgaria, Hungary, the GDR, Poland, the Soviet Union and Czechoslovakia and later Rumania and Cuba signed intergovernment agreements on cooperation in development, production and use of computer equipment in the national economy.

The technical level and volume of production of general-purpose computers (of the Ryad type), (small) control machines, microcomputers and microprocessors now guarantees the main needs of all countries of the community for them.

The problem of increasing the capacity of the main and external memories of the computers is being solved successfully by use of integrated circuits and large-capacity disks. Serial production of other external devices--automatic printing, displays, graph plotters and remote terminals--is also planned. The joint development of software is being organized and expanded. By the beginning of 1982, more than 100 applied program packs have been developed and are being used jointly. The use of programs developed by two or three countries became possible in the remaining countries of the community because the produced computers and peripheral devices are fully compatible technically, regardless of who produces them.

The dynamic development of computer equipment in CEMA countries is also the result of the activity of the Interngovernment Committee on Computer Technology, which, overcoming many difficulties, learned how to combine the creative efforts of scientific and technical personnel and production capacities. It is sufficient to say that more than 46,000 scientific and technical personnel and approximately 300,000 workers are involved in development and production of computer equipment in the participating countries of the community and that approximately 20 scientific research and more than 70 design organizations participate in implementation of coordination plans for joint operations.

Integration of the efforts of many countries makes it possible to develop and serially produce the entire range of electronic machines, external devices and programs within shore deadlines. The necessary replacement of computer generations is guaranteed because of this. Our countries are now successfully implementing the program for production of the Ryad-2 unified system, consisting of seven of the more modern models of computers and 80 types of peripheral devices. The development plan of the next, third generation of the Ryad-3 computers has been coordinated.

Similar work is being performed in the field of control computers. Production of small computers of new type, the CM-1420 and CM-1800, has begun. Together with organization of control computer production, more than 200 peripheral devices which are being produced or will be produced by CEMA countries have been developed or are underdeveloped.

The accumulated experience of the coordinated efforts in development and use of the latest equipment indicates the importance of further expansion and strengthening the cooperation of countries of the socialist community. This is especially necessary now when computer technology has received a new impetus for its development. A decision was made at the 35th meeting of the CEMA in 1981 on working out a program of cooperation on the problem of development and extensive use of microprocessor equipment in the national economy for 1982-1990.

To implement this decision, the secretariat of CEMA prepared a draft of the program which was considered and approved by the CEMA Committee on Scientific and Technical Cooperation. A general agreement was concluded in June 1982 on cooperation of CEMA countries in the field of microelectronics. Joint conducting of investigations in organization of cooperative production of a wide nomenclature of automated production complexes, machines and devices equipped with program-controlled microprocessor devices is provided in it.

The agreement envisions generalization of the accumulated experience in the use of microprocessor equipment and scientific research and experimental design work in development of microprocessor devices. Special importance is being devoted to personnel training and measures are planned to train and retrain specialists of higher and medium qualifications.

The program of cooperation contains more than 70 specific topics (tasks). A total of 52 pilot (standard) complexes and articles equipped with microprocessor devices should be developed and 28 complexes and articles will be delivered for serial production prior to 1990. Organization of the development of standard microprocessor systems by CEMA countries will permit acceleration of their assimilation in similar automated complexes by duplication.

According to preliminary estimates, the saving from implementation of the program during the period up to 1990 will comprise approximately five billion rubles. The saving will be achieved by increasing the labor productivity and by improvement of product quality and expansion of the functional capabilities and flexibility of control. A decrease of losses and reduction of energy and material expenditures are of no less important significance. The social significance of automatic control also cannot be disregarded: the nture of labor will be changed upon introduction of it and physical labor will be transformed to various types of mental labor.

Summarizing, one can state that success in development of microelectronics in combination with strengthening the cooperation of CEMA countries will guarantee a further rise and improvement of the socialist economy.

6521
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MICROPROCESSOR TECHNOLOGY DEVELOPMENT AND APPLICATION AND COOPERATION AMONG SOCIALIST COUNTRIES

Moscow EKONOMICHESKOYE SOTRUDNICHESTVO STRAN-CHLENOV SEV in Russian No 6, Jun 82 pp 14-16

[Excerpt from article by Yevgeniy Dudnikov, department head, International Scientific Research Institute for Control Problems, Vladilen Prokudin, department head, CEMA Secretariat and Boris Khaletskiy, consultant, USSR State Committee on Science and Technology]

[Excerpt] The CEMA member countries are placing major emphasis on the development and application of microprocessing technology. Many countries have accepted, and are successfully implementing, programs for more extensive introduction of the achievements of microelectronics - programs for integrated introduction of electronics into the national economy. However, the exceptional importance of this area for scientific and technical progress requires that the efforts of the socialist countries be combined on the base of a unified policy in the area of developing and applying microprocessor technology. Microelectronics is one of the seven priority regions of specialization and cooperation within the framework of CEMA.

With this in mind, the 35th Meeting of the Council Session in June 1981 instructed the CEMA Committee on Scientific-Technical Cooperation, with the involvement of the CEMA Standing Committee on Cooperation in the Area of the Radio Technical and Electronics Industry, the Intergovernmental Commission on Cooperation between Socialist Countries in the Area of Computer Technology and other CEMA agencies and international organizations of CEMA countries, to develop a draft program for cooperation among CEMA member countries for 1982-1990 to develop and implement microprocessor technology extensively in various areas of the economy.

The final goal of the program is the massive introduction to the national economy of systems, machines, instruments, equipment, etc. which employ microprocessor technology. For this reason, an inseparable part of the program must be the development of such systems for a sufficiently large number of areas in which the employment of this technology is effective.

This must be an integrated program, meaning that, in addition to developing applied systems for each area of application, it must also contain provisions

for the development of hardware and software to support these systems. An important section of the program involves the preparation and improvement of personnel in the area of microprocessor application, and popularizing and rendering consultative assistance on all matters involving microprocessor technology.

Applied systems should be developed by branch specialists who are thoroughly familiar with the singular features of specific applications, while microprocessor technology should be developed by specialists in the branches which produce that technology. The program must ensure cooperation between users who are developing applications systems and microprocessor technology producers. It must be kept in mind that there are specific requirements for each area of application but, at the same time, production requires unification of the component base, modules, peripheral devices and software. Consequently, a coordinated solution must be found as the result of joint efforts which responds to the capabilities of the microprocessor technology producers and satisfies the user requirements to the maximum extent.

In accordance with this, the draft program includes basic areas of cooperation:
--studying and disseminating experience gained in employing microprocessor technology in the economies of the CEMA member countries. These efforts will result in recommendations on setting up cooperation among CEMA member countries based on specialization and cooperation in production;
--developing microprocessor systems for various areas of the national economy in support of the most important, massive and efficient applications which can then serve as the base for the expanded introduction of microprocessor technology in individual branches, as well as setting up series production;
--developing microprocessor technology. This includes expanding the nomenclature of peripheral devices and software in accordance with user requirements;
--setting up a system for training and retraining specialists and creating national systems for teaching and consulting with microprocessor technology users.

Completion of the first section of the program will produce overviews of the status and trends of development and application of microprocessor technology which can then serve as the basis for developing recommendations for cooperation.

Projects under the second section are to provide prototypes of the corresponding systems or devices and to make recommendations for series production. Wherever these models are already in place and have been tested, their manufacture must be set up on defined scales based on division of labor and combined efforts among countries.

In accordance with the third section, peripheral and interface devices, devices for communicating with controlled objects and software which satisfy the user requirements indicated in the second section most fully will be expanded. There are also provisions for developing a large set of facilities for designing microprocessor systems which increase their efficiency significantly. This section also includes work to develop the microelectronic component base,

unified modules and families of universal microcomputers, to be carried out within the framework of the general agreement signed by the CEMA member countries in 1981.

The fourth section of the program contains plans to set up a network of courses to improve qualification ratings at universities, technical training schools and Academy and branch scientific-research institutes.

The draft program is made up of specific theme assignments which have been suggested by individual countries and included in the corresponding sections. These theme assignments have been analyzed in detail at a number of conferences of experts from CEMA member countries held in the fall of 1981 and the spring of 1982.

The CEMA Secretariat and the International Scientific-Research Institute for Control Problems took active participation in preparing for and conducting the preparatory work. The final version of the draft program was examined at the 25th session of the CEMA Commission on Scientific-Technical Cooperation in March 1982. That session also discussed the question of the forms of cooperation within the framework of the program and the implementation of an organizational mechanism for controlling its execution.

At the 103rd meeting held in April 1982, the CEMA Executive Committee adopted the draft program for presentation to the 36th Meeting of the Council Session, and instructed the CEMA Committee on Scientific and Technical Cooperation to prepare a draft general agreement to that end.

6900
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SERIAL PRODUCTION OF ISKRA-226 COMPUTER COMPLEX

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 1 Aug 82 p 2

[Article: "New Computer Complex"]

[Text] Serial production of the Iskra-226 computer complex has begun at the Kursk Plant Schetmash. This machine is a new generation of computer equipment. The innovation is being produced in cooperation with enterprises of the GDR, Bulgaria and Poland.

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DESIGN OF COMPUTER COMPLEXES BASED ON UNIFIED COMPUTER SYSTEM AND INTERNATIONAL SMALL COMPUTER SYSTEM

Kiev UPRAVLYAYUSHCHIYE SISTEMY I MASHINY in Russian No 3, May-Jun 82 (manuscript received 28 Jan 81, after revision 4 May 81) pp 60-66

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[Text] The development of heterogeneous multimachine complexes (MMK) requires solution of a number of problems of guaranteeing the joint functioning of hardware and software of the computers to be complexed. These problems were solved in one or another form during complexing of the YeS EVM [Unified computer system] with M6000 [1, 2] and YeS1010 [3] minicomputers. However, realization of the program for creation and development of the SM EVM [International small computer system] resulted in the fact that the dominant position among small computers in different sectors of the national economy began to be occupied by machines of a given series. This in turn generated the need to develop MMK based on these minimachines and the YeS EVM.

Some problems of MMK design that include the YeS and SM-3 or SM-4 (hereafter simply SM EVM) equipped with OS YeS [Operating system of Unified computer system] and OS RV [Real-time operating system], respectively, are considered in this paper. Development of the methods for complexing these computers is a very timely problem if one considers the wide application of YeS EVM and SM EVM in production and in the nonindustrial sphere on the one hand and the prospects for development of computer networks based on them on the other hand.

Designation, functions, and areas of application of multimachine complexes. The considered multimachine complexes are designed to increase the efficiency and reliability of information processing with minimum special requirements on hardware and software. The characteristics of these multimachine complexes should guarantee the capability of using them in the following main spheres: integrated control systems for complex, including distributed entities (production processes, experiments and so on), multiterminal collective-use systems, systems for automation of planning and design work (automated designer positions), automated ticket reservation systems, savings bank management systems, material-technical supply control systems and so on.

The following general requirements on the functions entrusted to multimachine complexes are typical for the enumerated spheres of application:

--data entry into the complex at the point of its occurrence;

--data display to devices located at the point of use;

--access to systems archives from terminals;

--calculations in dialogue and pack modes;

--solution of optimum entity control problems with issue of control operations in real time.

From the viewpoint of the geographic location of computers, the enumerated applications require both local multimachine complexes in which data is exchanged directly over computer channels and distributed complexes that utilize commuhnications lines.

It is known [4] that two basic methods of complexing are used in these cases. According to the first of them, linked complexes are created: one computer is the main machine and the remaining computers are subordinate with limited functions. The second method is used in design of symmetrical systems. Expansion of the functions of subordinate computers to achieve symmetry results in significant complication of realization of multimachine complexes and control of them. In view of this and with regard to the requirements presented above on multimachine complexes, creation of complexes with limited functions of subordinate SM EVM and primarily their use as programmable user stations (AP) for YeS EVM is feasible for a number of applications.

The interaction of computers in these multimachine complexes can be organized by using different methods [1, 3]. One of the simplest and most effective of them can be regarded as simulation of specific devices of the YeS EVM on the SM EVM. This approach was used, for example in [1] to simulate devices serviced by the graphical access method and in [2], where a magnetic tape was simulated. The main advantage of the simulation method may be the fact that it does not require any changes of the software (PO) of the Unified Computer System. Since software developments of the Unified Computer System in these systems determine the maximum labor expenditures, one may assue that the simulation method is preferable to other methods in realization of the corresponding devices of the function sof the multimachine complexes enumerated above. Based on the condition of use of the standard software of the Unified Computer System in multimachine complexes, let us consider the methods of access and the devices supported by them in the YeS operating system for selection of those of them that can be simulated in the International Small Computer System.

Methods of access of the YeS operating system. One can now talk about the use of the following methods of access realized in the YeS operating system [5, 6].

The graphical method of access (GDM) is designed to perform input-output operations by using machine graphics displays and devices. The most widely used

devices whose operation is supported by GMD are group control devices with portable displays (YeS7906). From the viewpoint of use in multimachine complexes, the graphical method of access is characterized by the guarantee of computer interaction with local devices, i.e., subconnected directly to the channel of the YeS EVM.

The basic telecommunications method of access (BTMD) is designed for application in programs that utilize communication both with local and remote terminals (user stations). It permits one to work with low- and high-speed devices in the start-stop and synchronous modes. The BTMD permits the use of only semiduplex switched channels. The given method of access supports the following devices of the YeS EVM: AP-61, AP-63, AP-70, the YeS7920 alphanumeric data display system and also telegraph equipment.

The general telecommunications method of access (OTMD) is a development of teleprocessing eqipment of the YeS operating system compared to BTMD and exchanges data both with local and remote devices. In the latter case the use of switched communications channels in the semiduplex or duplex modes is possible. The OTMD supports AP-2, AP-4, AP-61, AP-63 and AP-70 user stations, the YeS7906 group control device with portable displays, the YeS7920 alphanumeric data display system and can work with telegraph equipment.

The methods of access and the devices which are supported by them (+) or not supported by them (-) and which are of interest from the viewpoint of simulation on the SM EVM are presented in general form in Table 1.

Table 1. YeS EVM Devices and Methods of Access that Support Them

(1) Методы доступа	(2) Локальные устройства		(3) Удаленные устройства					
	(4) ЕС7906	ЕС7920	(5) АП-2	АП-4	АП-61	АП-63	АП-70	ЕС7920
(6) ГМД	+	—	—	—	—	—	—	—
БТМД (7)	—	+	—	—	+	+	+	+
ОТМД (8)	+	+	+	+	+	+	+	+

Key:

1. Methods of access
2. Local devices
3. Remote devices
4. YeS
5. AP
6. Graphic method of access
7. Basic telecommunications method of access
8. General telecommunications method of access

Simulated devices of the YeS EVM. According to the program for development of hardware for the YeS EVM, 19 models of user stations having different characteristics and functional designation are now produced [7]. From the viewpoint of application in multimachine complexes, only seven of them, presented in Table 1, are of interest. However, effective use of multimachine complexes based on the YeS EVM and SM EVM cannot be achieved due to the presence of only

the corresponding methods of access. Soviet and foreign practice of introducing teleprocessing systems shows that the presence of user programs in them, based on one or another method of access, is a comparatively rare phenomenon. Program packs oriented toward organization of remote pack processing, dialogue mode and so on, are used to the maximum extent in these systems. In this sense consideration of such packs of the YeS operating system as DUVZ, OKA, KAMA and so on is of interest.

The relationship of program packs of the YeS operating system, most widely used to organize remote processing corresponding to methods of access and devices of the YeS EVM, is presented in Table 2. Here the YeS7920(L) and YeS7920(U) are local and remote versions of the YeS7920 complexes.

Table 2. Program Support of Some User Stations of the Unified Computer System

(1) Методы доступа	(2) Пакеты ОС ЕС				
	ДУВЗ	СРВ	КАМА	ОКА	КРОС
(3) ГМД	(7) ЕС7906		ЕС7906	ЕС7906	
(4) БТМД	ЕС7920 (Л) ЕС7920 (У)		ЕС7920 (Л) ЕС7920 (У)	ЕС7920 (Л) ЕС7920 (У)	
(5) ОТМД		ЕС7906 ЕС7920 (Л) ЕС7920 (У)	ЕС7906 ЕС7920 (Л) ЕС7920 (У)		
(6) Физический уровень					АП-4

Key:

1. Methods of access
2. Packs of YeS operating system
3. Graphical method of access
4. Basic telecommunications method of access
5. General telecommunications method of access
6. Physical level
7. YeS

As follows from this table, the YeS7906 group control device with portable displays and the alphanumeric data display system in the local modification YeS7920(L) guarantee a direction with the same components of the YeS operating system and the YeS7906 device is supported by the GMD method for DUVZ and OKA packs, which operates only with its own graphical terminals, in addition to the YeS7906. If one takes into account in this case that the maximum number of displays in the YeS7906 is 16 and the maximum number in the YeS7920 is 32 and that the maximum rate of exchange of the YeS7906 with the channel is equal to 25 Kbytes/s, whereas this index is equal to 250 Kbytes/s for the YeS7920, it is obvious that further consideration of the YeS7906 device from the viewpoint of simulation of it makes no sense.

Thus, the given analysis of the methods of access that control program packs and that are supported by these components of the YeS operating system permits one to talk about the feasibility of simulating two devices of the YeS EVM: the AP-4 user station and the YES7920 alphanumeric data display system. Let us consider the characteristics and functions from the viewpoint of the earlier formulated requirements on multimachine complexes.

The AP-4 medium-speed user station (Figure 1) performs semiduplex exchange of data with the main computer according to the synchronous method of transmission. An unswitched telephone channel (A in Figure 1) is used for communications and the rate of exchange comprises 1,200 or 2,400 baud. Depending on the modification, the AP-4 unit may include a central device, ferrite core memory with capacity from 16 to 32 Kbytes, step magnetic tape storage unit, papertape input-output device, ATsPU [Alphanumeric printer], punch card input device and keyboard or display sequential printers.

The software and hardware for the AP-4 guarantee realization of the following basic functions:

--exchange of data with a remote computer in the pack or dialogue operating modes;

--data preparation on magnetic tape (up to eight users simultaneously);

--formation of pack from prepared messages for transmission to computer;

--integration of data preparation with computer exchange;

--buffering of received messages on magnetic tape;

--formatting and processing of received data according to algorithms used;

--data display to AP-4 users.

The YeS7920 alphanumeric data display system is produced in three modifications: a local group complex, remote group complex and remote single complex. The structure of each of them and their communication with the computer are shown in Figure 2. The remote single complex is not of interest from the viewpoint of simulation on the SM EVM and will not be considered henceforth.

A rate of exchange up to 250 Kbytes/s is guaranteed with local connection of the YeS7920(L) to the channel (K) of the YeS EVM. The YeS7920(U) complex exchanges data with the remote computer over unswitched telephone channels (A) by using the synchronous method of transmission at speeds of 600, 1,200, 2,400 or 4,800 baud.

The YeS7920 system includes a group control device (GUU), displays and printers. The total number of displays and printers connected to the group control device does not exceed 32.

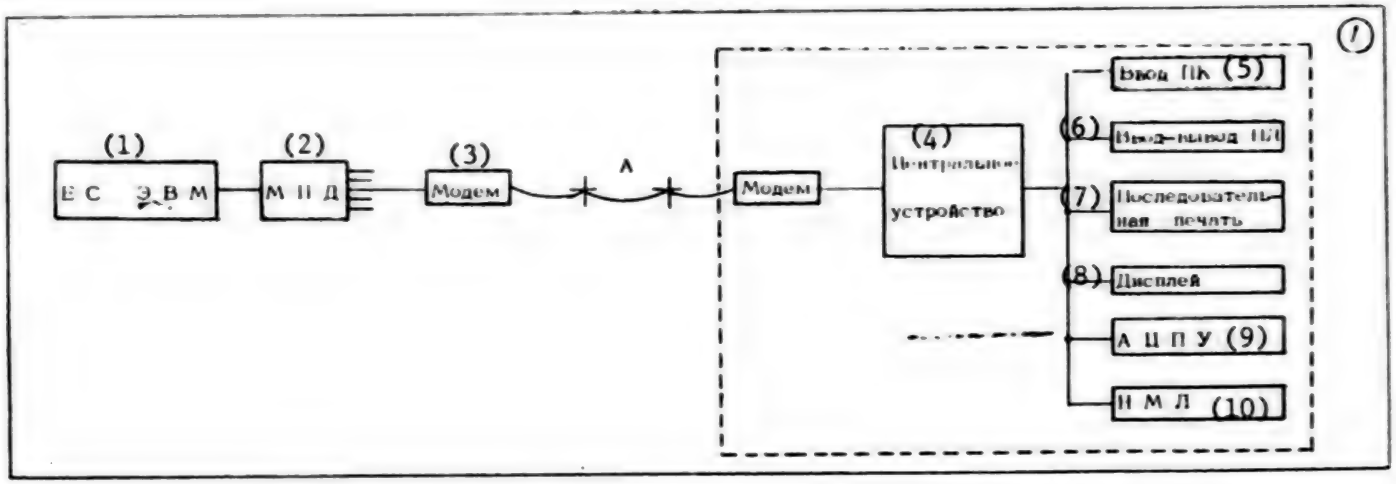


Figure 1. Composition of AP-4 User Station and Its Connection to YeS EVM

Key:

1. Unified Computer System
2. Data transmission multiplexers
3. Modem
4. Central device
5. Punch card input
6. Papertape input-output
7. Sequential printing
8. Display
9. Alphanumeric printer
10. Magnetic tape store

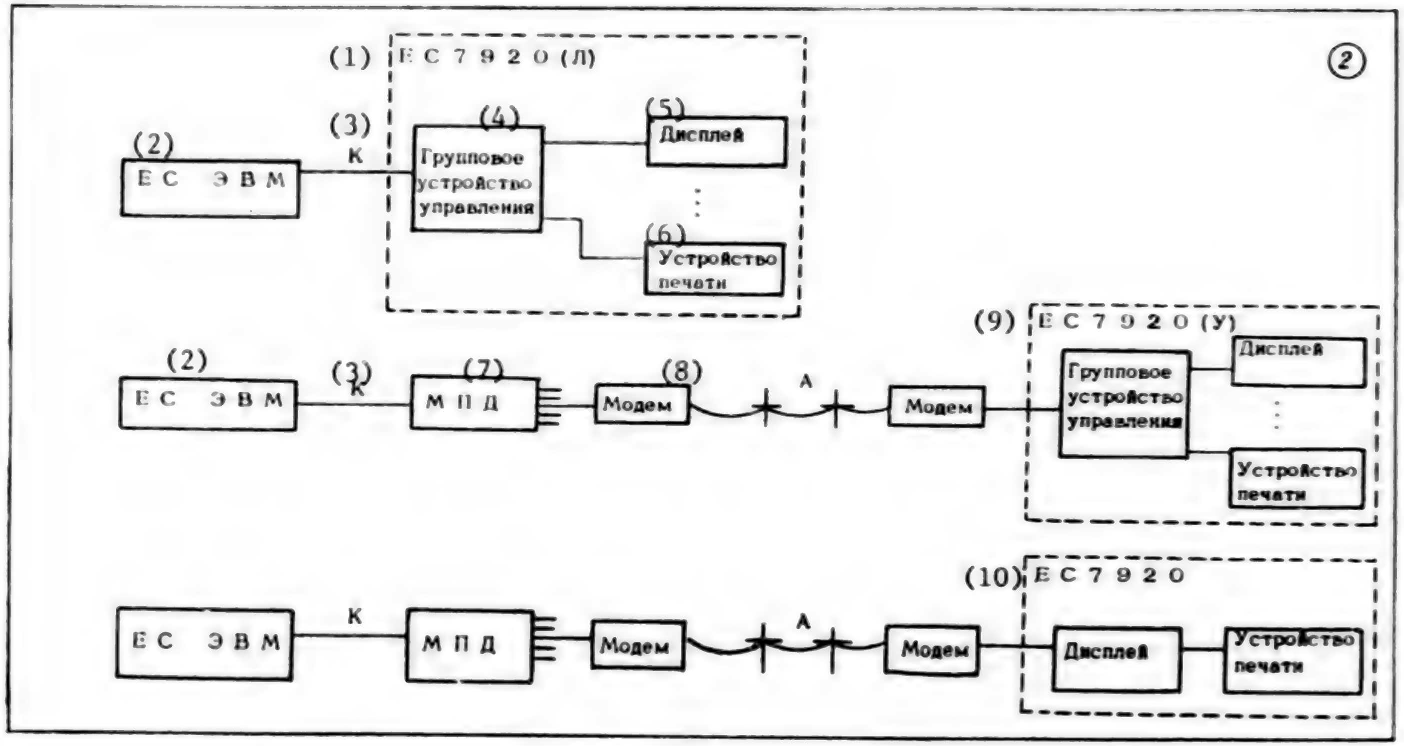


Figure 2. Structure of YeS7920 Complex: a--local group; b--remote group; c--remote single

Key:

1. YeS7920(L)
2. Unified Computer System
3. Channel
4. Group control device
5. Display
6. Printer
7. Data transmission multiplexer
8. Modem
9. YeS7920(U)
10. YeS7920

Both the local and remote YeS7920 complexes guarantee execution of the following functions:

--preparation and correction of data on the screen and simultaneously in the buffer memory of the display;

--transmission of the contents of the buffer memory of the display;

--data writing from the computer to the buffer memory and display of it on the display screen upon instructions from the computer;

--printing of the contents of the buffer memory to the printer when the functional key is pressed.

The given characteristics of the AP-4 and YeS7920 permit one to conclude that simulation of these devices on the International Small Computer System guarantees realization of the required functions of a multimachine complex since they accomplish remote and local entry and display of data, dialogue and pack modes of interaction with the YeS EVM, access to archives through the OKA and KAMA system and so on.

Let us now consider the hardware and software of the multimachine complex that include the SM EVM as simulators of the AP-4 and YeS7920.

Simulation of user stations of the YeS EVM on the SM EVM. The complexing hardware should guarantee the capability of organization of both local and remote interactions of the computers contained in the multimachine complex. From this viewpoint the computer integration device [8] for realization of local communications and the synchronous "SM common bus-standard junction S2" synchronous adapter for realization of remote communications are of greatest interest.

Considering complexing of the AP-4 and the YeS7920(U) complex, one may conclude that both devices should be simulated on the same hardware base of the SM EVM. This conclusion is determined by the following factors: both the AP-4 and the YeS7920(U) interact with the YeS EVM over unswitched telephone channels and both devices are group user stations of the YeS EVM.

Based on the foregoing, the hardware complex required to create a multimachin complex of the considered type can be represented in the form presented in Figure 3. It includes an SM-3P or SM-4P processor, systems console (Videoton 340 or VTA-2000 display), user displays, common bus and "SM common bus-synchronous junction S2" synchronous adapter.

The software of the complexes consists of basic and special software. As already noted, the basic software of the YeS EVM consists of the YeS operating system, program packs and the methods of access that support them. The multiprogram disk real-time operating system is used as the basic software of the SM EVM [8]. Special software of the SM EVM performs all functions of the simulated devices of the YeS EVM.

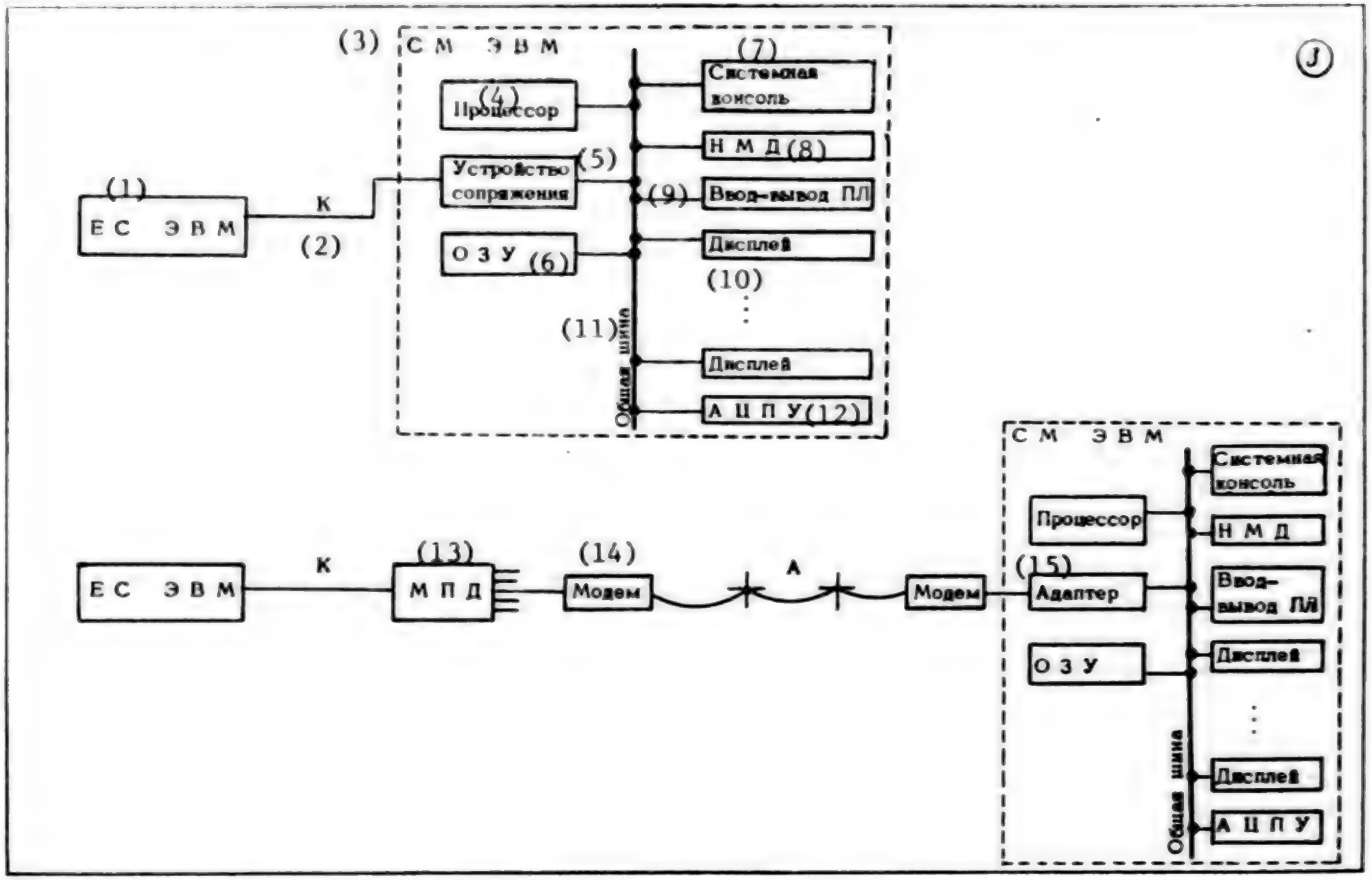


Figure 3. Structure of Simulator Hardware: a--of local YeS7920 complex; b--of remote YeS7920 complex and AP-4

Key:

1. Unified computer system
2. Channel
3. Internation Small Computer System
4. Processor
5. Integration device
6. Main memory
7. Systems console
8. Magnetic disk store
9. Papertape input-output
10. Display
11. Common bus
12. Alphanumeric printer
13. Data transmission multiplexer
14. Modem
15. Adapter

The structure and functions of the software for simulation of the local YeS7920 complex are determined to a significant degree by single addressing of the computer integration device from the direction of the YeS EVM channel and by the absence of service fields (user address, message length and so on) in messages formed for the computer integration device by programs that realize the corresponding methods of access. The combination of these factors results in the fact that information received from the YeS EVM cannot be compared to a specific user upon realization of the group device in the SM EVM if interrogations were transmitted from several of them to the main computer.

The given dircumstance determined the need to develop two modifications of the YeS7920(L) simulator--a single-channel and multipchanel, the software structure of which is shown in Figure 3 and in the inside back cover. Here P_i and R_j are user programs of the YeS operating system and the real-time operating system, respectively, Q_1 is the control program (pack) of the YeS operating system, for example, DUVZ, Q_2 is programs that realize the method of access (BTMD or OTMD), Q_3 is the driver program of the computer integration device, Q_4 is the auxiliary control processor of the real-time operating system that guarantees operational simulation of the GUU and the displays and Q_5 is "Pack instruction interpreter of the YeS operating system" control program.

Interaction of the software components of the multimachine complex is accomplished by using the following interfaces: I_1 is a means of interaction of the user programs with the control pack of the YeS operating system (Q_3), I_2 is macroinstructions of the method of access and I_3 is macroinstructions of intermachine interaction.

The single-channel simulator of the YeS7920 functions according to the following rules:

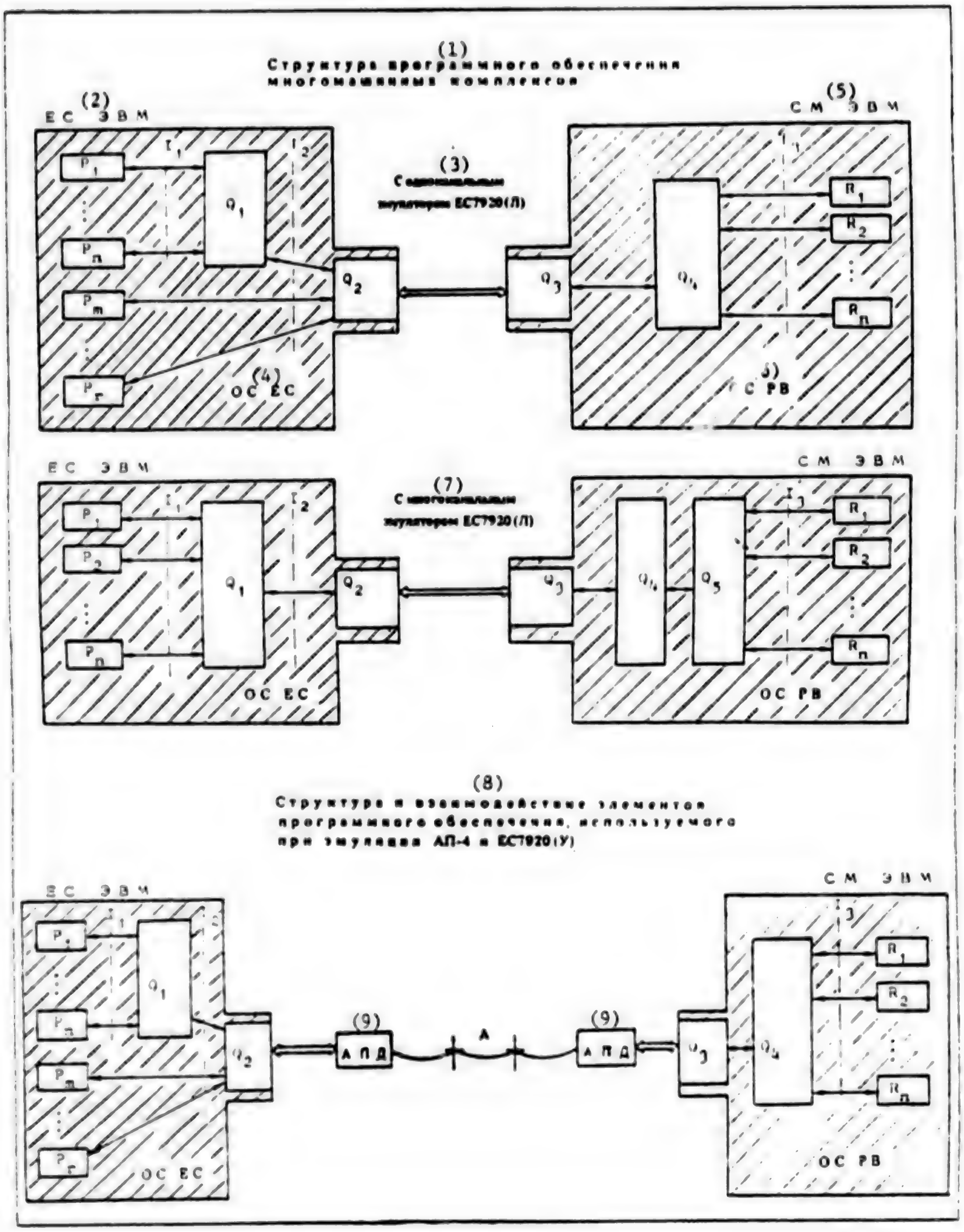
--any dialogue cycle between the pack Q_1 ot program P_i and program R_j is always initiated by the user program in the SM EVM;

--program channel Q_4-Q_3-Q_2 is a sequentially used resource and the channel is attached to it when any of the programs R_j is opened and is inaccessible to other user programs in the SM EVM before it is released or until completion of R_j;

--circuit Q_3-Q_4 realizes its own simulation of instructions of the YeS79[illegible] (L) device, providing a transparent exchange mode when working with any compo[illegible] ents of the YeS operating system that utilize the Q_2 method of access.

The basis for functioning of the multichannel simulator of the YeS7920(L) is the fact that the information transmitted to the YeS EVM contains both data for programs P_1-P_n and instructions addressed to pack Q_1. This sha[illegible]ing permits one to guarantee simultaneous interaction of several programs in the SM EVM with programs executed in the YeS EVM under the control of pack Q_1. Let us consider the functioning of a multichannel simulator in a multimachine complex where DUVZ is used as Q_1 in the YeS EVM.

As in the preceding case, when using a multichannel simulator, any lialogue cycle between program R_j and pack Q_1 or program P_i is initiated from the SM EVM.



[Key on following page]:

Key:

1. Structure of software for multimachine complexes
2. Unified Computer System
3. With single-channel simulator of YeS7920(L)
4. YeS operating system
5. International small computer system
6. Real-time operating system
7. With multichannel simulator of YeS7920(L)
8. Structure and interation of software components used in simulation of AP-4 and YES7920(U)
9. Data transmission device

However, several user programs in a multichannel structure can simultaneously open the logic channel for communicating with the corresponding software component of the YeS EVM. The information transmitted from programs R_j, as already noted, contains instructions addressed to the DUVZ and/or data itself.

The instruction interpreter of the DUVZ pack (Q_5) follows the transmitted instructions and if it detects an instruction that is a request for data exchange (for example, OUTPUT, EDIT and so on), it interlocks circuit Q_4-Q_3-Q_2 for the duration of this exchange. After reception-transmission of data, the indicated circuit is freed for work of other programs of the SM EVM. In this case information instructions and file transmission instructions can be distinguished among those addressed by the DUVZ. The first group includes requests to receive information about the status of files, programs and so on from the YeS EVM. The answers coming in to them are small in volume and are immediately transmitted to the corresponding program R_j. These instructions are processed the same as in a single-channel simulator.

File transmission instructions result in exchange of entire files between different computers of the multimachine complex. In this case circuit Q_4-Q_3-Q_2 is interlocked only for the duration of file transmission from the disk of the SM EVM to the YeS EVM or for the duration of file reception from the YeS EVM and buffering of it on the disk of the SM EVM. Since program R_j that transmitted the corresponding instruction to the YeS EVM is known in this case, the buffered file is assumed to belong to it. All subsequent instructions for receipt of information from this file, issued by R_j, summon reading of the following recordings from the disk and transmission of them to the program. A similar situation in a single-channel system results in constant exchange of data between the YeS EVM and SM EVM.

The AP-4 and YeS7920(U) complex are simulated with regard to the fact that the corresponding protocols are realized when working with BTMD and OTMD communications lines, i.e., they work with the address fields of messages and thus solve the problem of addressing several programs executed in the SM EVM and interacting with programs in the YeS EVM. Therefore, only multichannel systems are considered in developing simulators for these devices.

The software structure of the corresponding multimachine complex is shown on page 3 of the inside back cover. Here Q_4 is the auxiliary control processor that keeps a record of interaction according to the algorithms of the main

method of synchronous data transmission in KOI-7, synchronizer 1 (for the AP-4) or synchronizer 3 (for the YeS7920) and APD is the communications equipment of the YeS EVM and SM EVM.

Data is exchanged in this system according to the indicated record sheet of interaction and according to the use of the same standard interfaces I_1-I_3 as in other simulators. In the given case control program Q_4, besides keeping the record sheet and formatting the messages, performs supplementary functions that simulate operation of the group control device, guaranteeing transmission of information to the corresponding user programs R_1-R_n.

Let us consider to what extent and how the described simulators perform the functions of the corresponding devices of the YeS EVM.

Data exchange with remote and local computers, as was shown, is guaranteed by the set of programs Q_3 and Q_4 and in the multichannel simulator of the YeS7920(L) is guaranteed by control program Q_5.

The data are prepared (stored and edited) by standard equipment of the real-time operating system--exchange program between the carriers (PIP) and symbol editor (EDI).

The message pack for transmission to the YeS EVM is formed by the exchange program between carriers (PIP), which combines the messages into a single pack on a magnetic disk, and also by the program for reading the pack from the disk and transmission of it through interface I_3 to program Q_4, which forms the pack according to the record sheet used and which transmits it to the communications line.

As already indicated, messages received from the YeS EVM are buffered by program Q_4.

Formatting and processing of data received from the YeS EVM are accomplished by development of the corresponding programs that carry out processing according to the reuqired algorithms.

Data is displayed to users both by standard equipment of the real-time operating system (PIP) and by special terminal programs R_1-R_n that use macroinstructions of the interface and standard macroinstructions for exchange with terminals.

Macroinstructions for intermachine interaction. In conclusion let us consider the macroinstructions for intermachine interaction that realize interface I_3.

Six macroinstructions--open logic channel (NOC¤), closed logic channel (NCL¤), read message (NRD¤), declare subroutine for processing interrupt for receipt of message from YeS EVM (NAT¤), stop started operation (NKL¤) and write message (NWR¤)--are included in any of the considered macroinstruction systems of intermachine interaction.

Creation (destruction) of tables that characterize user programs as users of the multimachine complex is guaranteed by macroinstructions NOC¤ and NCL¤. The logic

channel for a single-channel simulator is the only one, while the number of logic channels open simulatneously is limited by the capacity of the main memory, allocated for the special software of the SM EVM, for a multichannel simulator.

Macroinstructions NRD¤ and NWR¤ guarantee exchange of information of the corresponding program R_j with the program in the YeS EVM. When the read operation is executed, the program receives the information buffered on the disk or the fact of issue of the macroinstruction is noted in its logic channel and it receives information immediately after the corresponding message comes in from the YeS EVM.

When using macroinstruction NAT¤, program R_j declares the address of the input point to which control will be transferred upon arrival of the message for this program. This mechanism of processing asynchronous interrupts guarantees the capability of combining data exchange and processing operations in user programs in the SM EVM.

Processing of all exchange operations started earlier by the program is stopped by macroinstruction NKL¤ and the corresponding logic channel is closed.

The considered hardware and software structures of heterogeneous multimachine complexes guarantee the capability of using the SM EVM as multiuser stations for the YeS EVM. The single program interface I_3, used in the special software of the SM EVM, guarantees execution of user programs R_1-R_n in any of the simulators without any modifications whatever.

The capability of the simulators working with new packs of the YeS EVM, including those based on the virtual telecommunications method of access, is guaranteed due to variation of those software components of the multimachine complex as Q_3 and Q_4. No modifications of user programs in the SM EVM of any kind are required.

The special software realized on the basis of the real-time operating system performs all functions of the simulated devices and a number of additional functions that increase the efficiency of using the user station.

The considered software of the multimachine complex was tested on the YeS1060 and SM-4, connected by a computer simulation device, at the internation exhibition "Equipment of the Unified Computer System and the International Small Computer System and their application." The YeS7906 group device was simulated on the SM-4 in this multimachine complex.

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STRUCTURES AND CAPABILITIES OF BIT-SLICE EXPERIMENTAL SYSTEM

East Berlin RADIO FERNSEHEN ELEKTRONIK in German
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[Text] The switching circuits for series K589 (USSR) and MH 3000 (CSSR) make available switching circuits by means of which it is possible to build up bit-slice microprocessor systems. The architecture and instruction inventory of these systems can be tailored to the problem solution. However, the effort to design the microprogram for bit-slice systems is greater than with microprocessor systems that have a fixed instruction set. This paper presents an experimental system by means of which microprograms, which were written for the implemented structure, can be tested.

Available MOS microprocessor systems work with a fixed instruction set and a fixed word length. For various applications, these do not provide the required working speed. In many such cases, microprogrammable bit-slice systems can provide a remedy. Their architecture, instruction set, and word length can be specified in accord with requirements.

The flexibility in the design of bit-slice microprocessor systems, with their problem oriented structure, is opposed by two disadvantages:

The development of bit-slice systems requires more hardware and software, compared to microprocessor systems that are based on microprocessors with a fixed instruction set. The bit-slice elements must be supplemented with a microprogram control and additional marginal electronics, so as to form functional systems. Furthermore, the microprograms, with their problem-oriented structure, must be programmed and tested, taking into account the selected hardware structure.

Because of the many degrees of freedom in the system design, there scarcely exist any development systems for the corresponding families of switching circuits.

The bit-slice experimental system TR 589 is presented below. This system is built up with the family of switching circuits K 589 (USSR). The TR 589 implements a typical 16-bit computer structure and is suitable to develop and test microprogrammed machine instructions and machine instruction sets, inasmuch as these are compatible with the given basic structure. The families K 589 (USSR) and MH 3000 (CSSR) are representatives of the Schottky-TTL technology. The most important ICs for building up a bit-slice system are summarized in the table. The functions of these switching circuits are described in references [1] and [2], and will be discussed in this paper only to the extent required for understanding the overall function.

The switching circuits of the series K 589 and MH 3000

Type	USSR		CSSR
Microprogram control unit (MCU)	K 589	01	MH 3001
Process element (CPE)	K 589	02	MH 3002
Fast transmission generator (CLG)	K 589	03	MH 3003
8-bit buffer	K 589	12	MH 3212
Interrupt control unit (ICU)	K 589	14	MH 3214
Bidirectional bus driver	K 589	16	MH 3216
Bidirectional bus driver, inverting	K 589	26	MH 3226

Structure of the TR 589

Figure 1 shows the hardware structure of the bit-slice system TR 589. This hardware consists of the following:

Central unit with 16 bit processing and addressing width, microprogram control and interrupt control unit

Two microprogram memories MPS 1 and MPS 2, which can be switched in optionally, and each of which has 512 microinstruction words with 40 bits each

A control section to generate the signals for the control bus of the system; here, this circuit also generates the signals for system start (RES) and for testing the machine programs in machine instruction steps (MAS) and the machine instructions in microinstruction steps (MIS).

A control keyboard for direct storage access (DMA) and for setting the interrupt points.

Peripheral data equipment, consisting of a cassette tape unit (KMBG), a paper tape reader (LBL), a paper tape punch (LBS), a telex (FS), a display screen (BSG), and an alphanumeric keyboard. This equipment is controlled through the associated interface complex.

A multichannel indication of the logic level, so that during machine instruction cycles or microinstruction cycles, all signals of interest (data bus, address bus, control bus...) can be traced.

EPROM for 12 Kwords with 16 bits each

RAM for 8 Kwords with 16 bits each

The hardware was eqipped with a microprogram which implements the instruction set proposed in reference [3]. This instruction set is stored in one half of the microprogram memory MPS 1. To expand the instruction set or to implement a completely independent instruction set, one can use the second half of the MPS 1 and the entire MPS 2.

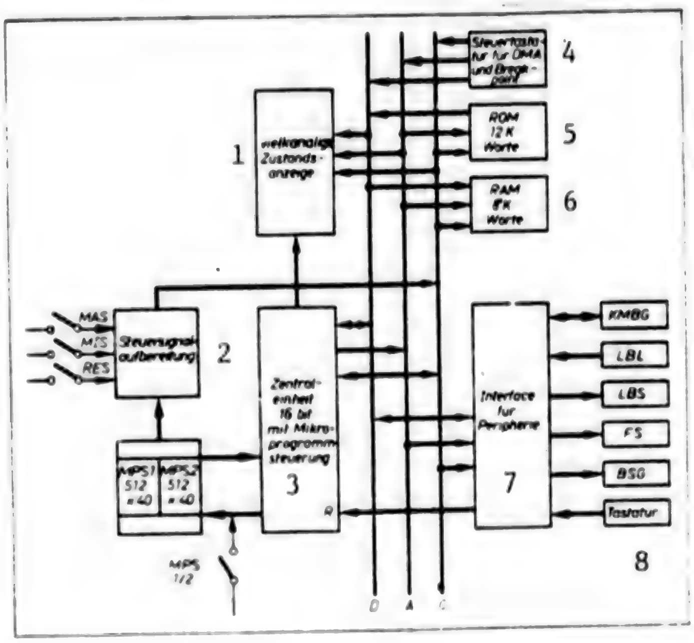

Figure 1: Hardware of the TR 589

1 multichannel status indicator
2 control-signal processing
3 central unit, 16 bits, with microprogram control
4 control keyboard for DMA and break point
5 ROM 12 Kwords
6 RAM 8 Kwords
7 interface for peripheral equipment
8 keyboard

An operating system was developed on the basis of the instruction set, where this operating system manipulates data in the memory (e.g. program revision) and works with the peripheral data equipment, via a command or command sequences. The operating system requires about 4 Kwords of the ROM region.

The TR 589 can optionally be controlled through the microprogram memories MPS 1 and MPS 2, and this affords the possibility, when the MPS 1 is activated, of loading the RAM with a program that has been written for the second instruction set stor in the MPS 2. Subsequently, after transferring control to the MPS 2, the machine programs or the microprograms can be tested.

Hardware

The hardware core of the TR 589 consists of the central unit (ZE), the microprogram memory (MPS), the control signal processing unit, the DMA channel, and the memory (RAM, ROM). It was generated as an application of the universally applicable hardware structure that has been described in reference [4]. The components belonging to this hardware core consequently will be described only to the extent necessary for the system application.

The multi-channel indicator circuits makes it possible to observe all interesting individual signals and information buses in single-step operation (in microinstruction steps and in machine instruction steps). It is therefore an important aid for testing the microprograms and also the machine programs. Its technical implementation will not be discussed in this paper; it has been described in detail in reference [5].

Central Unit

Figure 2 shows the basic circuit diagram of the central unit ZE. The ZE contains the CPE field, the interrupt control unit ICU, the microprogram control unit MCU, a pipeline register, and a bus driver for the address bus and the data bus.

CPE Field

The CPE Field is designed with eight bit-slice switching circuits for a processing and addressing length of 16 bits. The M- and D-buses are wired together to form a bidirectional data bus. The I-bus is connected with the D-bus interchanged bytewise, so that byte exchange operations can be performed. The K-bus (mask bus) of the CPE field is wired together group-wise according to Figure 3 , so that word and byte processing are possible through four bits which are presented in groups and additionally access to the highest-value bits of the bytes is also possible. The CPE field can be timed through the control bus separately from the other control units.

Interrupt Control

Interrupt acceptance is implemented in the proper priority by means of the ICU. The buses A and B of the ICU are connected with the lowest-value bits of the bidirectional data bus, to identify the reported interrupt level and to write in the current priority level. Through the control signal processing unit, the device address zero is permanently assigned to the ICU.

Microprogram Control

The X-bus of the MCU is connected with the high-value byte of the data bus. The machine instruction coded in this byte determines the starting address for the required microprogram sequence.

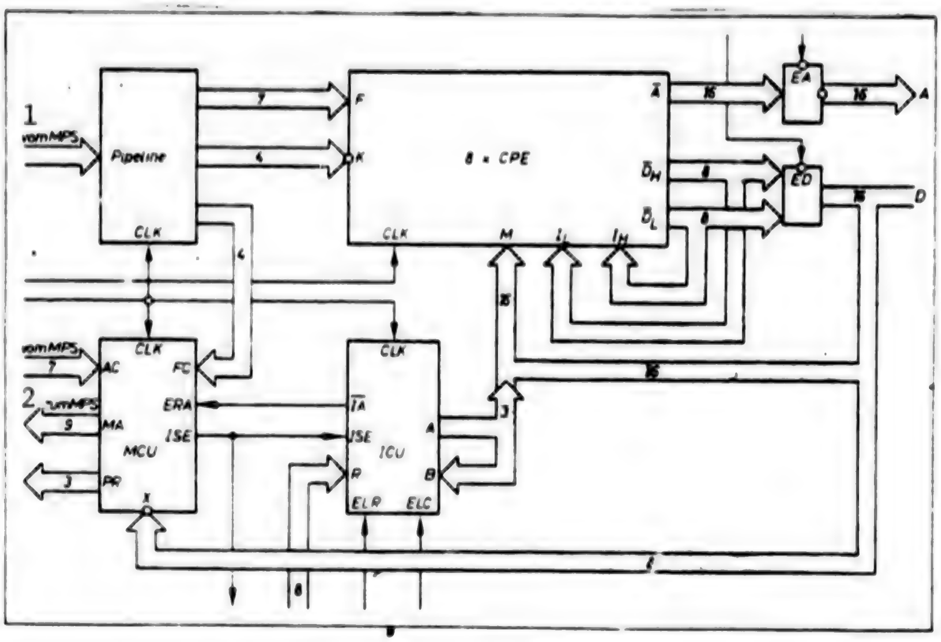

Figure 2: Block diagram of the central unit

1 from the MPS
2 to the MPS

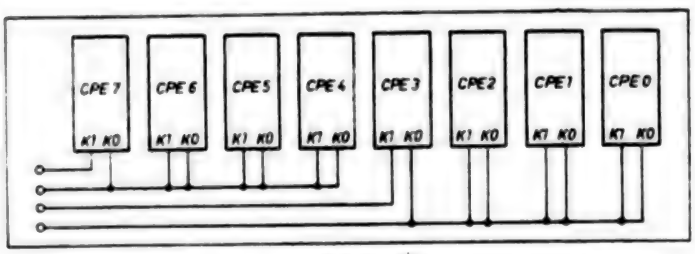

Figure 3: Summary of the K-bus by groups

Pipeline Register

The pipeline register makes it possible to, during the same time that the current microinstruction is being processed, already read the next following microinstruction from the MPS. In this fashion, it is guaranteed that a microinstruction can be processed in each cycle.

Microprogram Memory

The MPS consists of two identically structured storage sections, each with a capacity of 512 microprogram words, at 40 bits each. Which of the two MPSs is activated depends on the switch position MPS 1/2.

Figure 4 shows the structure of the microprogram word. When implementing further instructions, 15 bits of the microprogram word can still be used in a manner specific to the problem.

Control-Signal Processing

The control-signal processing unit guarantees the normal, undisturbed, program processing, as well as program processing in machine instruction steps and in micro-instruction steps. For example, through the C-bus (three bits of the microprogram word), work with the memories (read, write) and with the peripheral units (input, output), as well as the conditional suppression of the CPE cycle, is organized.

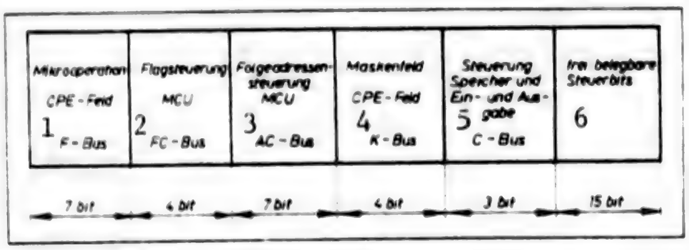

Figure 4: Format of a microinstruction

1 microoperation CPE field F bus
2 flag control MCU FC bus
3 consequential address control MCU AC bus
4 mask field CPE-field bus
5 control, storage, and input/output C bus
6 freely allocatable control bits

Step Operation

Step operation is set with the switches MAS (stop after machine instruction) and MIS (stop after microinstruction). Step operation, in conjunction with the multi-channel status indicator is a valuable aid for testing the micro- and machine-programs. The interesting individual signals and information buses can thus be traced in step operation.

Control Keyboard

The control keyboard is provided for DMA operation and for setting the interrupt points. In DMA operation, it is possible to control the memory contents through the multi-channel status indicator.

The interrupt-point circuit operates in such a fashion that, beginning at a prescribed starting address, the number of system cycles is measured until a prescribed interrupt address is reached. When the interrupt address is reached, a signal is emitted which can be utilized as an interrupt signal or as a stop signal. The number of measured cycles can be read on the multi-channel status indicator.

Memory

The TR 589 is equipped with EPROMs for 12 Kwords and with one 8 Kword RAM region. If necessary, the RAM and ROM regions within an address region of 32 Kwords can be distributed on arbitrary 4 Kword-long pages.

Peripheral Data Equipment

A device technology that is simple but that is adequate for microcomputer systems was selected for the peripheral data equipment. It consists of an alphanumeric keyboard, a television unit as a display screen unit, a telex, a commercial cassette tape unit and a paper tape station.

Short Description of the Software

The software for this system consists of the microprogram that implements the machine instructions and of an operating system which makes it possible to generate and test programs, and to input, store, and output data and programs through a command system.

Machine Instruction Code

The microprogram implements the instruction code in reference [3]. This instruction code contains among many other things:

Memory related instructions for implementing arithmetic and logical operations as well as instructions for loading registers and memories (including stack operations) in the following addressing modes: direct, indirect, indirect relative, indirect index, indirect index relative. Part of the instructions is also possible with direct operands.

Instructions for register exchange

Twelve conditional transfers and one unconditional transfer in the addressing modes relative and indirect

instructions for implementing the subprogram technology
shift instructions
byte instructions
I/O instructions

Operating System

Upon system start, which has been triggered by the RESET signal, the microprogram initializes the ZE. It is thus possible to make a definite entry into the monitor program, which makes possible conversational mode operation by means of keyboard input and display screen and/or telex output. By means of two library lists - one for the programs stored in the ROM and one for the program sequence which has been inputted in symbolic form is controlled. The processing of data and instruction sequences that have been inputted to machine code is likewise possible. Error messages essentially exclude operating errors. After the prescribed program or instruction sequences have bee processed, the monitor program again goes into its basic state and expects further commands.

The possibility of using separate program and data base registers permits the simple linkage of various conversion systems; an expansion of the already feasible modes of representing the information is thus possible without changing the monitor program. The monitor system can fall back on the following program complexes:

Conversational mode system which can process various text and data
Conversion system, which currently implements conversion of octal, hexadecimal, and integer representations into binary form and vice versa. Furthermore, this system contains routines for processing character chains which are used in the monitor.
Program for organizing the display screen display
Program complex to control the receiving complex
Programs to interpret the keyboard functions
Programs to control the paper tape station
Programs to control the cassette tape unit
Program to organize the RAM library list with symbolic nomenclature.

A program that is important for program testing is the interrupt-point routine by means of which, when the interrupt point has been reached, the status of the ZE (register contents) as well as the next instruction to be processed can be indicated. All the information indicated can be changed, and the computer continues its work with the altered status that has been generated in this way. A special interrupt-point circuit, in conjunction with this routine, permits step-by-step processing of programs with a clear acknowledgement of the results after executing the respectively current machine instruction.

Programs which work with the instruction code stored in MPS 2 can likewise be tested if, at the end of the instruction, an automatic switchover to MPS 1 takes place. However, in this operating mode, there are restrictions which depend on the structure of the second instruction code.

Summary

The bit-slice experimental system TR 589, which has been presented here, can be used as an autonomous microcomputer. Its operation as a microcomputer can be supported by the peripheral data equipment that is connected to it and by the operating system. Furthermore, it is possible to expand the existing instruction code within the framework of the available 256 microprogram words of the MPS 1, or to store a completely different instruction code in the MPS 2 (512 microinstruction words). For problem-specific controls, 15 bits of the microprogram word are then still available. One of the two microprogrammer memories is selected with a switchover circuit. Thus, for example, it is possible, by means of the operating system or the EMA circuit, to load programs into the RAM region, which have been provided with the second instruction code for their processing. After switching over to the MPS 2, the programs can then be tested in the microinstruction steps or in machine instruction steps. Individual signals and information buses that may be of interest here can then be traced by means of the multi-channel status indicator. The programs can be changed by means of the DMA circuit or, after switching over to MPS 1, by means of the operating system.

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8348
CSO: 1851/3

YeS-1045 DELIVERED AHEAD OF SCHEDULE

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 20 Jul 82 p 1

[Article by R. Gareyev, Chairman of Plant Trade-Union Committee of Kazan' Computer Plant: "Support for the Brigade]

[Excerpts] There are now hundreds of right-flight competitions at the Kazan' Computer Plant in honor of the 60th anniversary of the USSR that have considerably overfulfilled the personal tasks. A large part of them now work in brigades. This has permitted the plant collective as a whole to overfulfill the plan in volume of production during six months.

The success of the plant brigades is specifically expressed in ahead of schedule and high-quality fulfillment of the orders for delivery of modern coputer equipment. Thus, workers of the Administration of Northwestern Trunk Oil Pipelines received the YeS-1045 computer from Kazan' one quarter ahead of schedule. This same computer was delivered three months early to the Administratio of Production and Preventive Maintenance and makeup of equipment of the Tatneft' Association [Tatar Petroleum Association] and a number of other organizations.

6521

CSO: 1863/339

COOPERATIVE DESIGN OF SM 50/40

Kiev PRAVDA UKRAINY in Russian 31 Jul 82 p 3

[Article by Igor' Gorkun, special correspondent of PRAVDA UKRAINY]

[Excerpt] The two computer equipment systems operating within CEMA are now oreinted toward the use of microprocessors. I have in mind the unified system of large computers (YeS EVM) and the system of computers of "mini" class (SM EVM). The first swallow in this matter was the SM 50/40 computer designed by specialists of the Peoples Republic of Bulgaria, the Hungarian Peoples Republic, the Socialist Republic of Rumania, the USSR and the CSSR.

Like other representatives of the unified families of computers, the SM 50/40 computer is produced by a coordinated production program on the basis of international division of labor. For example, one can see in it magnetic disks manufactured by the Bulgarian Association Izot, printers made by workers of the GDR Peoples Enterprise Robotron and displays of the Hungarian firm Videoton. Microprocessors and also devices for communicating with control entities are produced by Soviet enterprises.

The workers, engineers and scientists of the fraternal countries are now participating in working out a cooperative program for 1982-1990 on development and extensive use of microprocessor equipment in the national economy of the countries included in CEMA. Production of a wide nomenclature of automatic equipment, machines, devices and control systems for machine building, power engineering, metallurgy, agriculture and transport will be assimilated as a result of implementation of this program.

Statistics are Indicative

Microprocessor devices are now being developed at unprecedented high rates. Whereas four generations of computers were produced during 30 years of the "start in life," the member countries of CEMA have not reached their fourth generation during 10 years since microprocessors appeared. This is the result of the presence of an enormous number of timely applications which microprocessors and microcomputers can provide.

Microprocessors can find application in more than 200,000 different types of devices and installations of industrial and service significance, which in itself is a technical revolution.

The system of management of the integration process in the socialist community should be applied so that an operational and effective answer can be given to the timely questions posed by life in the interests of all participating countries. The work of the headquarters of CEMA--its secretariat--is primarily directed toward this. As you, the reader, have already managed to note, a large international collective of representatives of all states included in the community is laboring here. It is they, the workers of the secretariat and representatives of all the fraternal countries who manage a large and important affair together and who actively affect the implementation of plans and agreements into real plans in which the continuous aspiration of the peoples of the socialist world to strengthen friendship and to widen cooperation are invited.

The need for collective discussion in the near future of such problems as bringing the structures of economic mechanisms closer together, development of direct contacts between ministries, associations and enterprises participating in cooperation and creation of joint firms was emphasized at the 26th CPSU Congress. As indicated in the decree of the CPSU Central Committee "On the 60th anniversary of the Union of Soviet Socialists Republics," "life itself posed the problem of supplementing the soordination of plans by coordination of economic policy as a whole to the fraternal countries." We are now observing this process. The world of socialism continues its historial rise.

6521
CSO: 1863/339

UDC 681.327.2

LASER COMPUTER INFORMATION RETRIEVAL DEVICE IN FORM OF TOPOGRAPHIC FORMATS

Novosibirsk AVTOMETRIYA in Russian No 2, Mar-Apr 82 (manuscript received 24 Jun 80) pp 3-6

[Excerpts from article by V. P. Bessmel'tsev, I. S. Degtyarev, V. P. Koronkevich, V. D. Kosterin, G. I. Murzin and Yu. N. Tkachuk, Moscow, Novosibirsk]

[Excerpts] Fast production of a large number of copies of images synthesized or processed in a computer is required in many cases, for example, such as processing aerial and space information in a computer. Devices are known [1-4] that permit retrieval of the information file in half-tone form onto photographic film. However, the real speed of these devices is limited by the process of developing the film, which is their serious disadvantage. A device that permits retrieval of half-tone and alphanumeric information onto a solid carrier without developing has been created at the Institute of Automation and Electrometry, Siberian Department, USSR Academy of Sciences, jointly with the Moscow Polygraphic Institute. The device can manufacture a typographic format with subsequent production of up to 10,000 prints from this format on ordinary topogrpahic printing machines.

Experimental results. An LG-25B current-stabilized infrared laser was used as the emission source in the laser computer inforamtion retrieval device. The output of the laser varied in the range of 10-40 W as a function of the material being used and the method of printing. The intensity of the recording emission was varied by an electro-optical modulator fo type ML-8 with forced cooling.

Transparent lavsan film 100-300 μm thick was used to produce the offset prints. A heat-sensitive coating was applied to the film for direct visualization of the retrieved information.

Commercial transparent sheet celluloid 300-800 μm thick was used as the material for high-print formats. The working side was covered with a thin layer of dye.

The photoformats for the offset print, produced when processing the same image on a computer, are presented in Figure 4. The half-tone regions included in the outline of the main image were determined by program. The size of the raster element was 200 μm in this case.

The test results showed the following technical specifications of the device: the size of the quantification increment of the image of 50 ± 2 μm, recording speed (depending on the method of printing) of 0.6 (0.3) m/s, size of the raster structure for the printed formats of 200 X 200 μm for offset printing and 50 X 50 μm for high-contrast printing, number of transmitted gradations > 16 and number of copies from the matrix manufactured by the device 10,000.

6521
CSO: 1863/190

UDC 621.382.8;681.327(088.8)

PHOTOMATRIX ASSOCIATIVE MEMORY

Novosibirsk AVTOMETRIYA in Russian No 2, Mar-Apr 82 (manuscript received 18 Feb 81) pp 13-19

[Article by S. F. Kibirev, S. I. Konyayev and S. I. Naymark, Novosibirsk]

[Text] The most realistic method of creating a relatively inexpensive large-capacity memory (10^8-10^{10} bits) with associative access properties is related to the use of a semiconductor buffer memory in the address memory [1]. This associative memory has been named a two-level or block-oriented memory. Specifically, a two-level associative memory can be developed on the basis of a magnetic disk and MDP [magnetic disk semiconductor] integrated associative memory [2]. Retrieval operations are performed in this case by the series-parallel method by recording and writing individual parts of the data file in the associative buffer. The indicated method has a significant limitation: a large fraction of time is expended on the operation of series recording of data in the associative memory (AZU). In this regard an advantage in speed is achieved only when solving complex associative data processing problems.

The operation of sequential recording of data is eliminated in the "page-organized holographic memory--optoelectronic AZU" structure (the latter is a semiconductor associative memory with optical input). Data is recorded in this case in parallel to all cells of the optoelectronic AZU by projection of the pages of data from the holographic memory onto the photosensitive inputs. High speed of data retrieval from the page-organized holographic memory (1,000 Mbit/s) with parallel recording and processing of pages of data in the optoelectronic AZU is combined in the considered structure of the two-level associative memory. This determines the potentially high productivity of the structure as a whole.

The main distinguishing feature of the optoelectronic associative memory is the design of the associative memory, which is a homogeneous matrix of L X N associative cells integrated with the corresponding photodetector array. We named this memory a photomatrix associative memory (FMAN).

The given work is devoted to problems of developing a photomatrix associative memory in the form of an optoelectronic BIS [large integrated circuit], the photodetector part of which meets the requirements of a permanent holographic memory by its geometric and optoelectronic parameters [3]. The structure of

an optoelectronic associative memory containing a photomatrix associative memory, the design and circuitry of the photomatrix associative memory made by MDP-integrated technology, and the results of functional tests and measurement of the optoelectronic parameters of experimental models of the photomatrix associative memory are considered in the work.

Photomatrix associative memory in structure of optoelectronic associative memory. The digital information files in the page-organized hologram memory are represented in the form of a sequence of holograms, in each of which a page of data K, consisting of L N-digit binary words ($k_{l1}...k_{ln}...k_{lN}$) ($l = \overline{1, L}$), is recorded. These words are the data file or set of features projected onto the photosensitive surface of the photomatrix associative memory in the form of dark and light spots upon restoration, depending on the type of processing.

The optoelectronic memory has a traditional structure in general features [4], shown in Figure 1, a: 1--a photomatrix associative memory, which is a matrix of memory cells, each of which contains an optical input and associatve processing circuit; 2--a L-digit address register; 3--a N-digit output register; 4--a N-digit retrieval independent variable register Z; 5--a N-digit mask register M; 6--a L-digit coincidence display with adjustable input logic; and 7--a control unit.

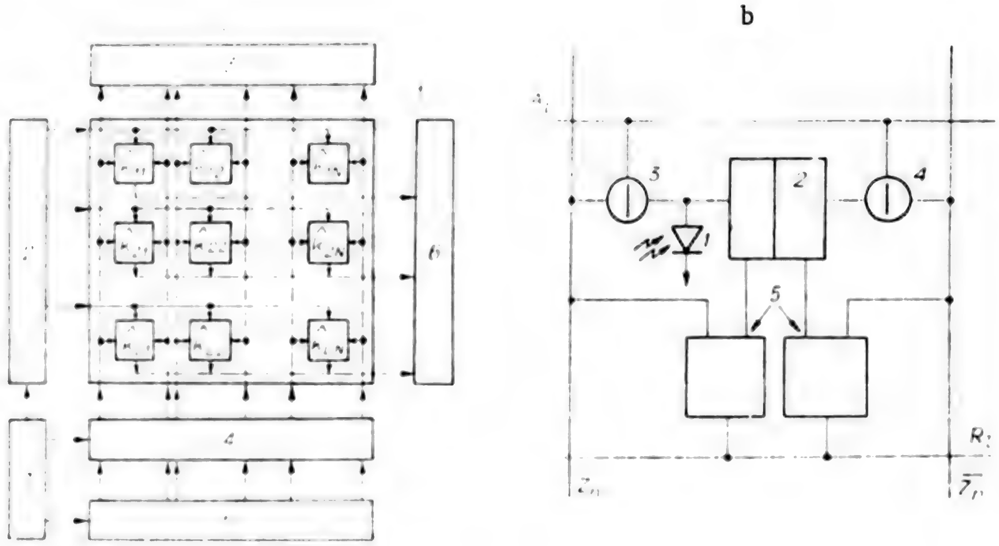


Figure 1.

The basic function of associative processing is the vector-function $R = \{r_l\}$, realized in parallel within the page $K = \{k_{ln}\}$ and determined by the equality

$$r_l = \sum_{n \in \{M=0\}} (k_{ln} Z_n + \bar{k}_{ln} \bar{Z}_n) \quad (1)$$

or

$$r_l = \sum_{n \in \{M=0\}} (k_{ln} \bar{Z}_n + \bar{k}_{ln} Z_n), \quad (2)$$

where Z_n is an n-digit binary code of the retrieval independent variable and k_{ln} is an n-digit binary word with number l written in the photomatrix associative memory. Summation is carried out for all unmasked digits, for which $M_n \neq 0$.

Since Z_n and k_{ln} can assume values of "0" or "1," one can determine summation in (1) and (2) in two ways. If summation is carried out in the ordinary sense, then the value of r_l is the Hamming distance between vector-word K_l and the vector-retrieval independent variable Z. If summation is defined in (1) and (2) as conjunction, then r_l indicates coincidence (with accuracy up to masked digits) of the retrieval independent argument and the word stored in the photomatrix adaptive memory.

In the simplest case the indicators of coincidence, which are threshold devices, record the value that exceeds the zero threshold, thus forming the vector-function R, adequate to the position address of the word coincident to code Z. This word can be rewritten by means of the address register to the output register and can be transmitted over a communications channel.

The functional diagram of the photomatrix associative memory cell, in which the following microoperations required for operation in the optoelectronic associative memory are realized, is presented in Figure 1, b: parallel electric recording of the N-digit input word by the given addresses ("Electric recording"), parallel optical recording of L, N-digit binary words ("Optical recording"), parallel reading of the N-digit binary word by the given address ("Read") and parallel realization of the function R in the L X N-page ("Interrogation").

Each cell of the photomatrix associative memory consists of a photodetector 1, memory element 2, write-read elements 3 and 4 and comparison element 5. The cells in the memory are joined by two orthogonal line systems. The first of them consists of N pairs of digit write/read lines Z_n, $\bar{Z}_n$ that join the matrix columns and the second consists of L address lines A_l and L coincidence lines R_l that join the matrix rows. The system of address lines A_l guarantees dictionary access to the memory matrix with electric write/read. The coincidence lines $\{R_l\}$ guarantee fulfillment of the function r_l for each word stored in the memory and as a special case fulfillment of function rl--reading of the digit cuts of words. The photodetector can be regarded as a supplementary access for writing information to each cell. In the general case functioning of the photomatrix associative memory cell is described by means of the system of equations

$$\left\{\begin{aligned} &\hat{k}_{ln}(t+1) = Z_n(t)a_l(t) + k_{ln}(t) + k_{ln}(t+1),\\ &\tilde{k}_{ln}(t+1) = \hat{k}_{ln}(t+1)a_l(t+1),\\ &r_{ln}(t+1) = [\hat{k}_{ln}(t+1)Z_n(t+1) + \overline{k_{ln}(t+1)}\,\overline{Z_n(t+1)}]M_n, \end{aligned}\right. \tag{3}$$

where $k_{ln}(t + 1)$ is the status of flip-flop 2 at time (t + 1), $k_{ln}(t + 1)$ is the n-th digit of the word read from the Z-, $\bar{Z}$-lines at time (t + 1), $r_{ln}(t + 1)$ is the value of the "Equivalence" function realized in comparison circuit 5 on

lines $\{R_l\}$ for each photocell, M_n is the value of the n-th masked digit and a_l is the signal from address line A_l.

Circuitry and design of the photomatrix associative memory. The circuitry of the photomatrix associative memory cell shown in Figure 2, a contains photo flip-flop, modified with respect to [5], on MDP transistors T1-T4 and a photodiode FD. MDP transistors T5 and T6 operate as through keys for writing and reading information. The logic circuit on transistors T7, T8 and T9, T10 is two AND circuits whose inputs are connected to the arms of the flip-flop and the interrogation lines, respectively, as shown in Figure 2, a. The outputs of the AND circuits are connected to the OR line, realized by coincidence lines $\{R_l\}$.

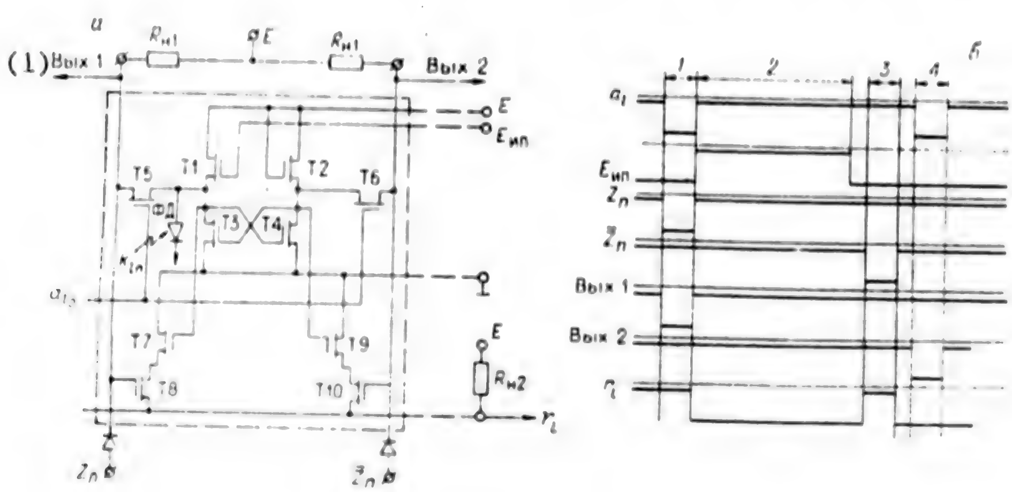


Figure 2.

Key:
 1. Output

Let us consider the functioning of the cell on the example of the following sequence of mic.ooperations: electric writing of "0," optical writing of "1," interrogation by independent variable Z = "1" and reading of "1." The pulse diagram of the control (a_l and E_{ip}), input (Z_n, $\bar{Z}$, k_{ln}) and output (Vykh 1, Vykh 2, r_l) information signals is shown in Figure 2, b, where 1 is electric writing, 2 is optical writing, 3 is interrogation and 4 is reading.

Electric writing is accomplished in the photomatrix associative memory cell by feeding to the corresponding address line A_l a high potential which opens keys T5 and T6 and switches the digit lines Z_n and $\bar{Z}_n$ to the inputs of the flip-flops. Potentials corresponding to the value of the digit of the written word in paraphase code are fed to this pair of digit lines. A high potential whose value corresponds to the condition of nondestructive reading, is fed through the load to the digit lines in the case of a masked digit. Either the status of the flip-flop is confirmed or the arm of the flip-flop with high potential is discharged through the grounded digit line during writing. while the opposite arm is charged through the load transistor to a high potential. Thus, writing

a zero in the flip-flop corresponds to a high potential on the channel of transistor T4.

During optical writing, load transistor T1 is cut off by the zero potential on the gate (see E_{ip} in Figure 2, b) so that the photodiode is disconnected from the conducting circuits during the microoperation of optical writing and operates in the photocharge storage mode. The anode of the photodiode is actually connected to the input of the amplifier stage on MDP transistors T4, T2 and T3, surrounded by positive feedback. Variation of voltage on the anode of the photodiode, caused by luminous flux with energy of an optical "1," leads to triggering of feedback, and the photodiode capacitor is discharged through feedback transistor T3. In this case the voltage on the opposite arm of the flip-flop is increased to the level of a logic "1."

The process of optical writing is completed by feeding a cutoff potential to the gate of T1. In this case the information entered optically is statically memoryized and stored until cutoff of the power supply source. The photo flip-flop in this mode is approximately 10^2 times less sensitive to the output of the luminous flux, since the photocurrent should considerably exceed the current passing through the load transistor.

Potentials corresponding to the inverse word-independent variable (wtih respect to the word during writing) of interrogation in paraphase code are fed to the paris of digit lines when performing the microoperation "Interrogation." The zero potential on both lines correpsonds to the masked digits. IF the paraphase code of the independent interrogation variable on the lines coincides with the status of the memory element, the comparison circuit based on transistors T7-T10 is in the conducting state and current passes through load R_{n2} along line R_1. If there is no coincidence, then there is no current in load R_{n2}. Words can be read from the photomatrix associative memory by feeding an address signal along line A_1 (see a_1 in Figure 2, b). In this case information is read from the flip-flop through lines Z_n, $\bar{Z}_n$ on the load resistors in paraphase code. Bypasses made in the form of keys or diodes D1 and D2 (see Figure 2, a) are required in order that the output resistors of the interrogation register (see Figure 1, a) do not shunt the output signals of the cell. The microoperations of electric and optical writing, interrogation and reading can be followed in an arbitrary sequence according to the control microprogram of the photomatrix associative memory. This guarantees adequate functional completeness, flexibility and adjustability of the optoelectronic associative memory to provide a calculating algorithm for solving a specific associative retrieval problem.

Experimental models of a photomatrix associative memory with 12 X 12 dimensions of the photocells was manufactured in the form of an integrated circuit by p-channel MDP technology with silicon gate. A photograph of the microcircuit crystal is presented in Figure 3, a. The dimensions of the photomatrix associative memory crystal were 5 X 5 mm, the spacing between photodetectors was 0.3 mm and the dimensions of the photodetecting surface was 0.1 X 0.1 mm. The photosensitive element of the circuit was a p-n junction, which is a specially magnified channel-source region in one of the arms of the flip-flop circuit. The photosensitive element operated as a photodiode biased in the opposite direction and the photocharge storage mode was used to write optical information

[6]. The photomatrix associative memory crystals were placed in a planar 48-lead housing with transparent window (see Figure 3, b).

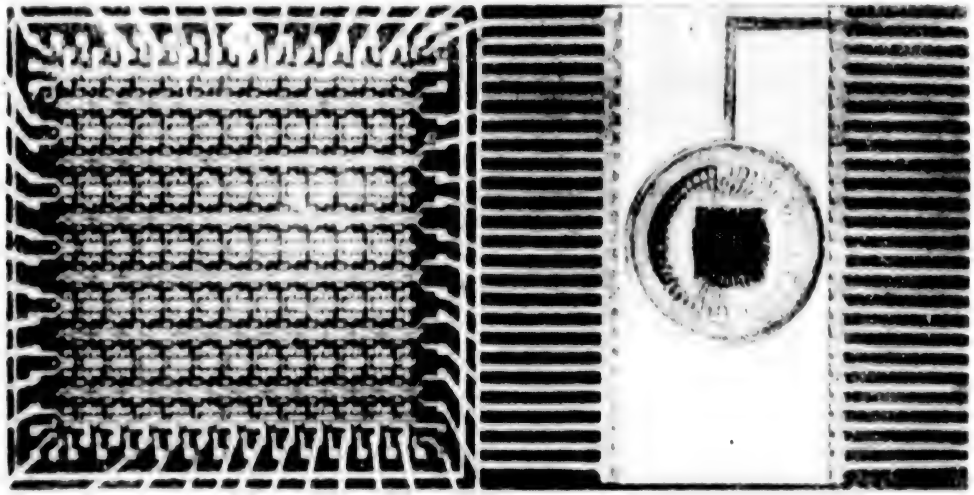
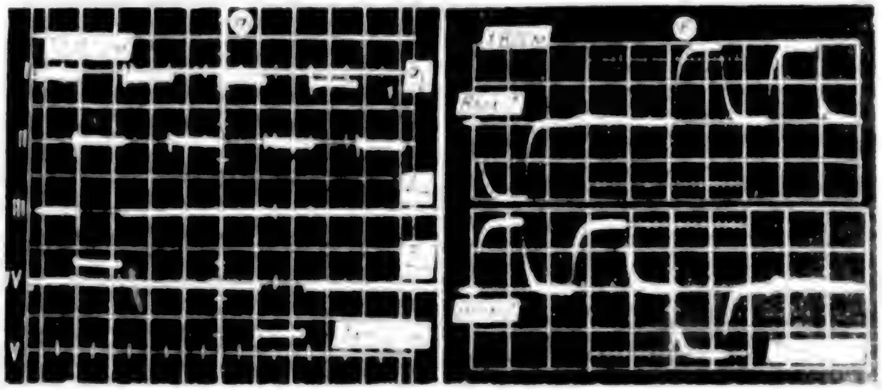


Figure 3.

Experimental results. Discussion of results. The photoelectric and functional parameters of the photomatrix associative memory were measured by using equipment [7] consisting of a multichannel programmable generator, regulated power supply sources E1 and E2 and a coherent light source (λ = 0.63 μm) that focuses the optics and adjusting accessories.

The multichannel programmable generator was used to control the control diagram of the photomatrix associative memory photocell, which was monitored by a five-channel oscillograph. The luminous flux focussed to a spot 50 μm in diameter was recorded by a calibrated photodiode and was directed to the photosensitive surface of the photomatrix associative memory cell simultaneously with delivery of the control diagram to the corresponding lines.

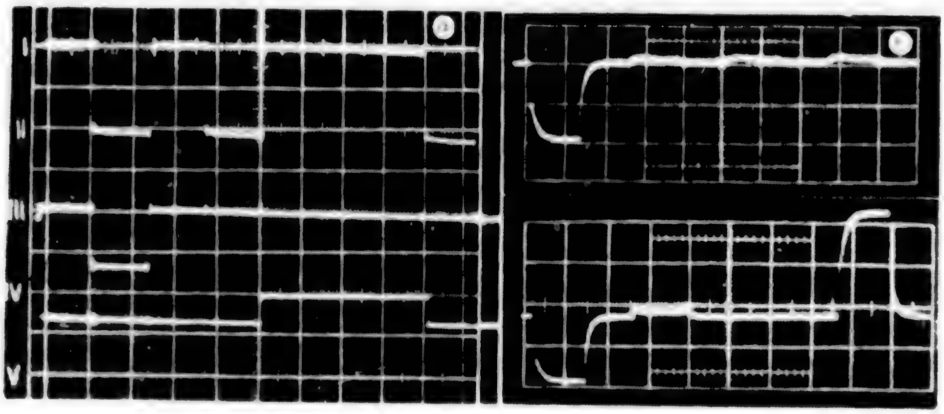
Figure 4.



Tests containing pairs of microoperations: "Electric write-read," "Optical write-read" and "Electric write-interrogation" (Figures 4-6), were used for convenience in observations of the signals on the oscillograph.

An oscillogram of the control voltages for the "Electric write-read" test is shown in Figure 4, a and an oscillogram of the response of the cell read from load resistors R_{n1} is shown in Figure 4, b. The first group of pulses on lines A_1, Z_n and $\bar{Z}_n$ denote writing of information $Z = 1$, $\bar{Z}_n = 0$ to the flip-flop and in this case the voltage on the load resistors R_{n1} follows the written information (Figure 4, b). The second pulse through address line A_1 (see Figure 4, a) interrogates the status of the flip-flop. The third group of pulses in Figure 4, a determines writing of $Z_n = 0$, $\bar{Z}_n = 1$ to the flip-flop, while the fourth pulse on line A_1 interrogates the flip-flop.

Figure 5.



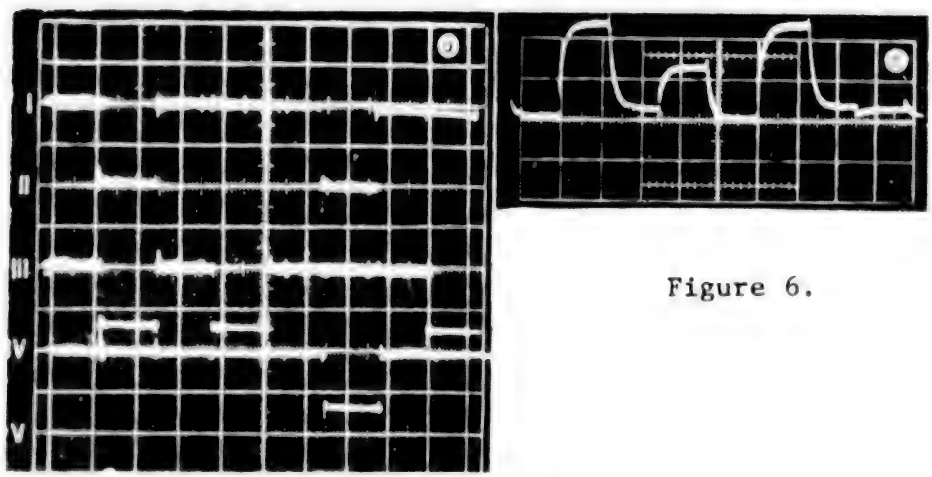


Figure 6.

Oscillograms of the "Optical write-read" test are shown in Figure 5, a and b. The oscillogram of Figure 5, a illustrates the photocell control diagram. The first pulse through the address line authorizes presetting of the flip-flop to status "0." To do this, the code "0" and "1" is fed along lines Z_n and $\bar{Z}_n$ such that the capacitor of the photodiode is charged as a result of resetting. The second pulse checks the status of the flip-flop through the address line. Load transistor T1 (see Figure 2, a) is cut off by the signal E_{ip} (see Figure 5, a) during the next "optical write" cycle itself. In this case the photodiode operates in the photocharge storage mode. The third pulse through address line A_1 checks the results of writing. The response of the photocell to the test is presented in the oscillograms of Figure 5, b and c for the cases $k_{1n} = 0$ and $k_{1n} = 1$.

The "Electric write-interrogation" test (Figure 6) was used to illustrate the operation of the photomatrix associative memory in the comparison mode with the retrieval independent variable. The first pulse through the address line (see Figure 6, a) authorizes presetting of the flip-flop to status "0" by the potentials on digit lines Z_n and $\bar{Z}_n$. The contents of the flip-flop with code Z_n and $\bar{Z}_n$ are compared during the next cycle. The third cycle is writing to flip-flop "1" and the fourth cycle is comparison to the same code. An oscillogram of the output signals on load circuit R_{n2} is shown in Figure 6, b. The result of comparison is shown in the second and fourth cycles.

The threshold energy of switching the flip-flop did not exceed 10^{-12} J/cell at power supply and control voltages of -12 V for emission of wavelength $\lambda = 0.63$ μm of a helium-neon laser. The sensitivity of the photocell can be increased by reducing the power supply voltages. In this case the noise resistance of the circuit is reduced. Another factor that limits the sensitivity of the circuit includes asymmetrical spurious pulse noise, occurring during switching of the load MDP transistor. However, a decrease of the effect of pulsed noise due to a decrease of amplitude E_{ip} is possible.

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INCREASING ELEMENT SIZE STABILITY IN PROJECTION PHOTOLITHOGRAPHY

Novosibirsk AVTOMETRIYA in Russian No 2, Mar-Apr 82 (manuscript received 20 May 80, in final form 9 Mar 81) pp 86-92

[Article by V. B. Gurskiy and R. Ye. Pyatetskiy, Minsk]

[Excerpt] Experimental results. The range of the mean rates of development of exposed strips in regions with different thicknesses of SiO_2 film and photoresist with and without control of exposure time on the basis of model function $H^*(R_0)$ was compared to check the model. For this purpose, four plates with stepped relief of the oxide (Figure 6) were manufactured by photolithography and selective etching of thermal SiO_2. The cross-hatched vertical strips represent regions with SiO_2 film, while the blank strips represent pure silicon. Each strip of oxide has a thickness from 1 to 0.3 μm, which varies by 60-90 nm from strip to strip.

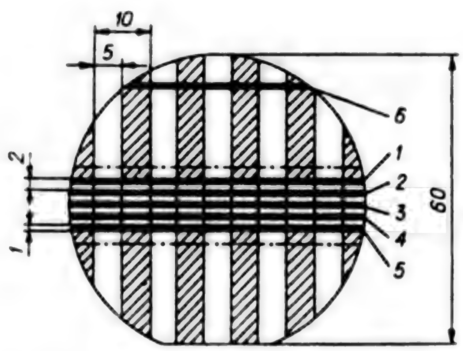

Figure 6. View of Developed Plate

AZ-1350J resist 480-560 nm thick was applied to the plate. The reflection coeffcient (λ = 436 nm and the width of the sounding beam was diaphragmed to 2 mm) was measured on a Beckman UV-2500 spectrophotometer in the region determined by the dashed lines, in the center of each of the SiO_2 strips and one of the SiO_2 strips with zero thickness (a total of 28 points). The six horizontal lines (their dimensions and position is shown in Figure 6) were then exposed on each strip. Exposure was also carried out on an EM-542A duplication and blending machine with ZhSS and ZhS-12 filters (λ = 436 nm). Each of five central lines was exposed with its own exposure time, which varied from τ_{max} to 0.6 τ_{max}

at intervals of 0.1 τ_{max}. The optimum exposure time for the given installation and the resist, used in the commercial exposure mode, was taken as τ_{max}. The sixth line was exposed with time of τ_{max} and was used to determine the conditions of development.

The plates were dried at 100°C for 20 min after exposure by the method suggested in [18] to equalize the residual concentration of inhibitor $M(z, H_e)$ through the thickness of the photoresist film.

The exposed strips were developed in an AZ: H_2O = 1:1 solution at 20°C. The top (sixth) strip was developed first and the time t of total development was determined. The entire plate was then immersed in the developer and was developed for time $t_1 < t$ such that none of the five central strips were fully developed. A layer of aluminum 20-30 nm thick was sprayed onto the plates after development. The depth of the strips etched in the resist on each of the oxide steps were measured for five exposures on an MII-4 interference microscope with accuracy of 20-30 nm. The measurement data for one of the plates are presented in the table.

Нормированное время экспозиции τ/τ_{max} (1)	Коэффициент отражения R_0, % (2)						
	20,6	35,7	18,1	33,1	6,1	8,8	25,5
	Глубина травления, нм (3)						
1	447	270	330	290	466	399	330
0,9	421	268	308	270	440	358	320
0,8	339	218	260	234	355	270	285
0,7	270	117	150	178	270	191	211
0,6	194	105	140	162	220	164	164

Key:
1. Normalized exposure time τ/τ_{max}
2. Reflection coefficient, R_0, percent
3. Depth of etching, nm

The results of the measurements are shown in Figure 7 in the form of histograms. Histogram a corresponds to depths of etching of strips exposed during τ_{max}. Histogram b shows the effect of exposure control. It was plotted in the following manner. The required exposure time τ^* was determined for each SiO_2 strip of the considered plate by the reflection coefficient R_0 measured for it from the approximated curve H^* (R_0) (the lower branch of curve $H(R_0)$ corresponding to h_{ph} = 525 nm in Figure 5 was taken as curve H^* (R_0). The depth of etching l^*, corresponding to exposure time τ^*, was then determined by interpolation on the basis of data of the table of depths for this plate. Histogram b was then plotted on the basis of the values of l^* found in this manner.

It is obvious from the histograms of Figure 7 that the range of depths of etching of exposed strips for regions of plates with different thicknesses of SiO_2 film and photoresist decreased by a factor of 2.5 as a result of exposure control. The range of mean rates of development also decreased by the same factor, which is the consequence of equalizing the residual concentration of inhibitor and is good agreement with the calculated value.

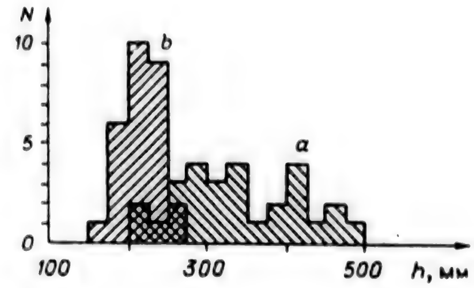

Figure 7. Histograms of Depths of Etching: a--without exposure control; b--with exposure control

Conclusions. One of the possible approaches to solving the problem of reducing the instability of the element size in projection photolithography, based on measurement of the energy reflection coefficient R_0 at local points and exposure control by it at these points, was investigated at the paper. In this case control was accomplished by the dependence of exposure time H on R_0 calculated from the model for each specific substrate-film system. It was shown and confirmed experimentally on the example of Al-Ph and $Si-SiO_2-Ph$ systems that exposure control by the suggested method during generation of the figure on relief substrates permits a reduction of the range of rates of development of the elements on the plate at least by a factor of 2-3 compared to the case without exposure control. Equalization of the rates of development should result in a decrease of the range of element size in approximately the same proportion. However, a precise answer to the question of reducing the instability of size during exposure control can be obtained only by direct experiment.

The functions $H(R_0)$ for all the substrate-film systems used in production of the IS (integrated circuit) must be calculated and entered in the computer controlling the operation of the image generator for practical realization of the method according to the existing model. The exposure time H is proportioned according to the model function $H(R_0)$ at each exposed point of the substrate on the basis of the measured reflection coefficient R_0 for a specific computer system. Thus, the second problem requiring solution is to develop a high-speed device for local real-time measurement of the energy reflection coefficient R_0.

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PHOTODETECTOR BASED ON SCHOTTKY BARRIER AND ISOTYPE HETEROJUNCTION

Novosibirsk AVTOMETRIYA in Russian No 2, Mar-Apr 82 (manuscript received 9 Oct 81) pp 105-107

[Article by B. S. Vakarov, I. S. Vakarova and V. N. Vishnyakov, Odessa]

[Text] Photosensitive structures having sign inversion in the photocurrent spectrum and that are thus of specific interest of the viewpoint of their use in optoelectronics devices [4] have been reported on in a number of papers [1-3]. The indicated feature of photocurrent is determined by separation of the light-generated current carriers by two space charge layers located at different depths with counterdirectional internal electric fields.

The results of investigating the photoelectric properties of the metal--$n^+Al_xGa_{1-x}As$-nGaAs structure, which is a combination of a Schottky barrier (metal--$n^+Al_xGa_{1-x}As$) and a heterojunction ($n+Al_xGa_{1-x}As$--nGaAs) are presented in the paper. The presence of two nonequivalent space charge regions in the given structure determines the shape of the spectral distribution curve of photocurrent: two points are observed in it in which the photocurrent changes sign.

Al(GaAs)--GaAs isotype heterojunctions were created by liquid-phase epitaxial growing on a GaAs substrate of $Al_xGa_{1-x}As$ solid solutions with different molar fraction of aluminum ($0.2 < x < 0.7$). The epitaxial layers were alloyed with tellurium and their thickness after surface treatment for application of the metal layer was 20-30 μm. The grown solid solutions had variable composition in a direction perpendicular to the surface of the layer and the width of the forbidden zone decreased as the distance from the interface decreased with gradient of approximately 0.01 eV/μm. The carrier concentration in the GaAs substrate was $\sim 10^{16}$ cm^{-3} while the level of alloying of the epitaxial layer was appreciably higher at 10^{18} cm^{-3}. Ohmic contact to the substrate was accomplished by fusion of In [5] and the Schottky barrier was accomplished by chemical precipitation [6] of a semitransparent layer of gold onto the surface of the solid solution, treated by standard methods.

The photoelectric properties of the structure were investigated by the synchronous detection method in the short-circuiting current mode with zero bias and with delivery of bias of both polarities. The structure was illuminated from the direction of the solid solution.

The results of measuring the structural photocurrent distribution j_f of structures with different value of parameter x at $\sim$ 300 K are shown in Figure 1. The photosensitivity spectra contain two points of sign inversion of photocurrent and one point of inversion (a) was observed for all the investigated structures at $h\omega \simeq$ 1.43 eV, which corresponds to the width of the forbidden zone of GaAs (E_{g2}), while a second point of inversion "b" was located in the spectral range of 1.65-2.05 eV as a function of the value of parameter x. Its position coincides rather well with the width of the forbidden zone of $Al_xGa_{1-x}As$ on the boundary with the metal (E_{g1}).

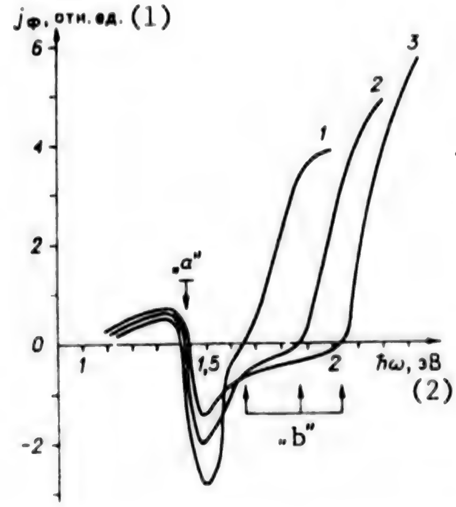

Figure 1. Spectral Distribution of Photocurrent j_f with Zero Bias of M--$n^+Al_xGa_{1-x}As$--nGaAs Structures with Different Molar Fraction of Aluminum x: 1--0.2; 2--0.4; 3--0.7

Key:
1. Relative units
2. eV

A zone diagram of the investigated structure is shown in Figure 2. It was taken into account when plotting it that the break in the valency zone is close to zero [7] in the GaAS--Al(GaAS) heterojunction and that the height of the barrier ϕ_v is determined by the ratio $\phi_v \simeq (2/3)E_{g1}$ for metal--n $Al_xAs_{1-x}As$ Schottky barriers ($0.2 < x < 0.7$) [8]. Three types of optical junctions are noted in the diagram which can be realized at different photon energies of the investigated spectral band.

According to [1], the photocurrent of a structure with two potential barriers is described by the expression

where j_{f1} and j_{f2} are the photocurrents related to separation of the light-generated carriers by the fields of barriers I and II, respectively, and k is the ratio of the differential conductivity of barriers II and I. Photocurrent in the photon energy range of $h\omega$ = 1.0-1.43 eV ($\phi_v < \hbar < E_{g2}$) is determined by electron emission from the metal to the epitaxial film and by their separation in the field of the Schottky barrier ($j_{f2} = 0$, $j_f > 0$). Absorption in the GaAs

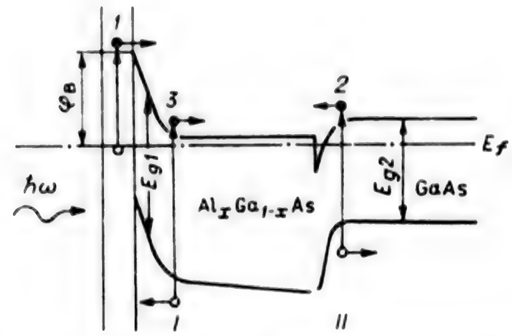

Figure 2. Energy Zone Diagram of M--n^+Al(GaAs)--nGaAs Structure: 1--photoemission of electrons from M to Al(GaAs) solid solution; 2--separation of carriers by field of heterojunction II; 3--separation of carriers by field of Schottky barrier I.

substrate begins as the photon energy increase ($E_{g2} < \hbar\omega < E_{g1}$), since photons with energy less than E_{g1} freely pass through the wide zone "window." Moreover, absorption initially proceeds beyond the region of the "dip," since the optical width of the forbidden zone in this region is increased due to the presence of an inversion layer.

The light-generated carriers are separated by the electric field of the heterojunction and inversion of the photocurrent sign and a sharp increase of it in the negative zone occur ($j_{f2} > kj_{f1}$, $j_f < 0$). However, beginning at photon energy $\hbar\omega \approx 1.5$ eV, a decrease of the negative photocurrent is observed, possibly related to the fact that the main absorption occurs directly in the region of the dip of the zone of conductivity and the greater part of the light-generated electron-hole pairs recombines rapidly, making no contribution to photocurrent.

The "window" effect ceases to operate with a further increase of photon energy ($\hbar\omega > E_{g2}$), the usual interzone absorption in the solid solution begins and the photocurrent again changes its sign since the photocarriers are separated in this case by the field of the Schottky barrier ($j_{f2} = 0$, $j_f > 0$).

It should be noted that the photosensitivity in regions 1 and 2 is much less than that in region 3, since the photocurrent of the Schottky barrier is much less than that in the region of the natural absorption of the semiconductor due to electron emission from the metal [9], while the surface potential barrier ϕ_v must be overcome by the carriers generated in the GaAs substrate and separated by the field of the heterojunction.

Moreover, the value of the negative maximum photocurrent in the range of photon energies of $E_{g2} < \hbar\omega < E_{g1}$ depends on the molar fraction of aluminum x in the solid solution (see Figure 2) and decreases as the value of x increases, i.e., as the width of the $Al_xGa_{1-x}As$ forbidden zone increases. A similar principle is obviously related to an increase of the energy gap in the zone of conductivity in the heterojunction, the value of which determines the fraction of electrons passed through the heterojunction and accordingly the value of photocurrent.

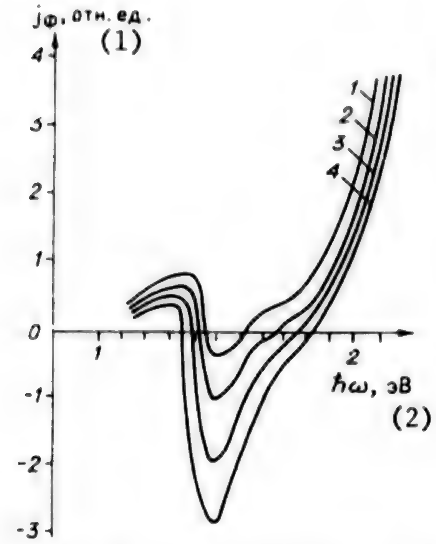

Figure 3. Spectral Distribution of Photocurrent of Structure with x = 0.3 at Different Bias Voltages U, V: 1-- -1.0; 2-- -0.5; 3--0; 4-- +2

Key:
1. Relative units
2. eV

The results of investigating the effect of bias voltage on the photosensitivity of the structure are presented in Figure 3. The observed variation of the spectral distribution of photosensitivity and the position of point "b" of sign inversion of photocurrent were determined by variation of the differential conductivity of barriers I and II (variation of the value of k in the expression for j_f). Indeed, the height of the potential surface barrier ϕ_V increases when a negative bias is applied (which corresponds to reverse bias for a Schottky barrier) and the height of the heterojunction barrier correspondingly decreases, which also leads to more effective separation of the photogenerated carriers by the field of the Schottky barrier. Accordingly, the photocurrent in the region of $h > E_{g1}$ increases, it decreases in the region of $E_{g2} < h\omega < E_{g1}$, while the point of inversion "b" shifts toward lower photon energies. In similar fashion, the bias of opposite polarity has an inverse effect on the spectral characteristics of the photocurrent.

It should be noted that the presence of three sections differing by sign in the spectrum of photocurrent is observed at ∿ 300 K, whereas a negative maximum is either generally not observed in the photodetectors suggested in [2] or it is detected only at ∿ 80 K. This difference is related to the fact that the photoelectrons emitted from the metal to the semiconductor and separated by the field of the Schottky barrier pass to the external circuit almost unhindered in the investigated structure. For the same reason the voltage drop $\Delta\phi$ occurring on junctions I and II when the structure is illuminated by light with photon energy $h < E_{g2}$ is small and accordingly the spectral position of point "a" of the sign inversion should be weakly dependent on the light intensity [1].

When the structure is illuminated by light absorbed in the GaAs substrate, the photogenerated electrons are forced to overcome the potential barrier ϕ_V, which leads to their accumulation in the epitaxial layer and to an increase of $\Delta\phi$. Accordingly, the spectral position of point "b" of the inversion should depend to a greater extent on the illumination. Nevertheless, this dependence is not very strong due to the fact that j_{f2} drops sharply in the considered structure, as was indicated earlier, when the photon energy approaches the value of E_{g1}, while the value of j_{f1} increases sharply.

The lux-ampere characteristic of the specimens remained linear while the spectral position of the points of inversion of the sign of phtocurrent "a" and "b" remained unchanged in the investigated range of illuminations (up to $\sim 10^{-3}$ W/cm^2) with accuracy up to 0.01 eV. This range of illuminations is an order less for the structure suggested in [1].

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SOFTWARE

AUTOMATIC DATA BASE DEVELOPMENT - A QUALITATIVELY NEW STAGE IN DEVELOPMENT OF STATISTICS

Moscow EKONOMICHESKOYE SOTRUDNICHESTVO STRAN-CHLENOV SEV in Russian No 6, Jun 82 pp 30-32

[Excerpts from article by Valeriy Nazarov, CEMA Secretariat]

[Excerpts] Considering the importance and difficulty of automatic data base development in CEMA member countries, a meeting of the CEMA Standing Commission on Cooperation in the area of Statistics instructed that a Temporary International Scientific-Research Collective be set up within the framework of the Commission, to consist of specialists of interested CEMA member countries to develop the theme "Creation and Application of Automatic Data Bases for the Unified Computer System (YeS EVM)". The work program of the Temporary International Scientific-Research Collective includes the following design phases for the YeS EVM automatic data base:

--principles of developing and applying automatic data bases;
--standard technical assignment for developing and implementing automatic data bases;
--standard technical draft for developing and implementing automatic data bases.

The statistical agencies of individual CEMA member countries already have automated data bases, but most of them are generally intended for commercial purposes and do not fully satisfy the requirements of statistical services. By studying the experience which has been gained in various countries in operating them and by analyzing the operation of existing automatic data bases, the Temporary International Scientific-Research Collective was able to combine the efforts of the countries in developing and defining a unified conception and higher requirements for the statistical data base.

In the first stage of cooperation, the Temporary International Scientific-Research Collective, according to the plan, developed the principles for creating and implementing the ASGS [Automated State Statistics System] automated data base for the Unified Computer System. This document served as the coordinated foundation for scientific-research work to develop statistical data bases for interested CEMA member countries, and was aimed at expanding

international cooperation in the area of statistics. It was developed on the basis of analyzing existing experience in CEMA member countries on this matter in consideration of the prospects for development of automated statistical data processing systems.

The principles for creating and implementing the Unified Computer System automatic data base represent the coordinated opinion on the defintion of automatic data base, its place within the automated state statistics system and its structure, construction and operation conditions. These concern the system which controls the data base, its functions and singularities, allowing for the specific properties of statistical data and the relationship between the data base control system and operating system, the data base control system communications facilities and problems involved in implementing the data base control system. A data base must support the handling of regular jobs, information-reference service and actualization. Software is provided for solving regular problems which facilitate on-line updating of the data base, which increases the accuracy of statistical information and reduces the difficulty of making changes in the data base.

The software allows the data base to be expanded freely, and permits new tasks to be entered without changing the logical or physical organization of the base.

The draft has definite advantages over the data processing systems now in use in the statistical agencies of a number of CEMA member countries because of the rational utilization of the data base and modern computer technology.

The automatic data base is considered as a subsystem of an automated statistical system which provides the following integrated data processing capabilities:

--one-time input of minimum amount of source data, repeated utilization of the data and conversion to provide various statistical processing and corresponding output tables;
--the availability of an interrelated system of statistical indicators used to characterize a particular phenomenon as a whole, or individual aspects thereof;
--tie-in of various territorial levels in the processing of statistical data.

In the next stage of activity, the Temporary International Collective developed a standard technical assignment for the creation and application of the Unified Computer System automatic data base.

The main advantage of the standard technical assignment is its integrated approach to problems which are to become the subject of analysis of the draft treatments of the automatic data base. This creates the prerequisites for unifying the draft treatments for the automatic data base within the framework of international cooperation. It was possible in drawing up this document to generalize materials which can be used for statistics as well as other branches and departments.

The next stage in the activity of the Temporary International Scientific-Research Collective in 1981 was the development of a Standard Technical Draft for the creation and application of the ASGS automatic data base for the Unified Computer System. A necessary condition for the functioning of the automatic data base is the availability of a unified statistical methodology at different levels -- from bottom to top -- and a system for gathering and processing data from the statistical agencies of the countries. The draft indicates that the data base is to be created in stages, allowing for the degree of preparedness of the information-reference fund and available ASGS automatic data base hardware.

The goal of creating the standard technical draft includes the following:

--promoting the development of national automatic data bases to the level provided by the standard technical assignment for creation and application of the ASGS automatic data base;
--creating methodological foundations for promoting and developing national automatic data bases which will provide ASGS data exchange among CEMA member countries in the future;
--developing standard treatments and promoting the creation of new, and the development of existing, automatic data bases in the CEMA member countries considering specific conditions and singularities.

The standard technical draft also deals with such questions as the organizational and functional structure of the automatic data base, the interaction between automatic data bases at different levels with data bases in other automated systems, information support, data base operating conditions, automatic data base hardware and software and efficiency criteria.

The sections of the standard technical draft contain alternative draft treatments which are intended for use as methodological guidance. In examining organizational and functional structure, the technical draft generalizes the existing directions regarding automatic data base creation which were taken into account in developing the draft. The criteria which determine the choice of treatment include the requirement for analytical information at the corresponding levels, the amount of data, including source, that processed and stored in the automatic data base and that transmitted, as well as the hardware composition.

One of the essential evaluation criteria for the automatic data base is the simplicity and convenience with which a subscriber (user) -- the statistician -- can use it. The automatic data base outputs the requested data, processes it, and outputs ready results in the required form: reports, groupings, trends, etc.

The software structure in the standard technical draft is made up of a data base control system, a data base processing system and a remote data processing system.

These components interact closely and are themselves divided into subcomponents,

with the latter being divided further into modules.

The ASGS automated data base control system is the fundamental part of the automatic data base and, from the viewpoint of the overall structure of the data base, is the programming system which allows the applications programs to communicate with the data base.

In contrast to previous documents, the technical draft develops efficiency criteria for the application of the automated statistical data base and formulates the concepts of efficiency. The latter are based on exploiting the savings achieved by using the ASGS automatic data base as compared with the design, introduction and operating costs.

The 38th session of the CEMA Standing Commission on Cooperation in the Area of Statistics adopted the Standard Technical Draft for the creation and application of the ASGS automatic data base for the Unified Computer System, noting that it had been fulfilled successfully. Delegations from Bulgaria, Hungary, the Socialist Republic of Vietnam, GDR, the Republic of Cuba, the Mongolian People's Republic, the USSR and Czechoslovakia agreed to use this draft to create and implement ASGS automatic data bases, allowing for the specific conditions present in those countries.

At the same time, automatic data base organization in state statistical agencies requires further investigation both on the theoretical and practical plane. In this connection, the CEMA Standing Commission on Cooperation in the Area of Statistics recognized it advisable, at the 38th meeting, to begin work in 1982 on the theme "Creation and application of distributed ASGS automatic data base for the Unified Computer System". In order to achieve quick results, this theme will be developed within the framework of the Temporary Scientific-Research Collective. The GDR delegation agreed to coordinate the work on this theme. A distributed automatic data base is a system of interconnected local automatic data bases set up following unified principles of methodological and information support and hardware and software, combined by a statistical data teleprocessing system. This combination of local automatic data bases makes it possible to bring the location at which data is stored closer to its sources, to reduce the overall flows of statistical data significantly and to create favorable conditions for the use of this data while reducing the relative cost of automatic data base operation.

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ANALYSIS OF PROGRAM RELOCATION METHODS FOR K580IK80 MICROPROCESSOR

Kiev UPRAVLYAYUSHCHIYE SISTEMY I MASHINY in Russian No 3, May-Jun 82 (manuscript received 17 Jun 81) pp 35-38

[Article by engineer Oleg Antonovich Parnyuk, Candidate of Technical Sciences Aleksandr Kirillovich Teslenko and engineer Aleksandr Aleksandrovich Shevchenko, Kiev]

[Excerpts] The simplicity of realizing a functionally complete computer or control system and the comparatively high speed (500,000 R X R format operations per second) permit the use of the K580IK80 or KR580IK80A microprocessor for design of both the simplest controllers that control various types of production and measuring equipment and specialized computers that operate with small memory capacity and for realization of comparatively complex multiprogram single-processor or multiprocessor systems.

The instruction system of the K580IK80 microprocessor guarantees addressing of 64K bytes of memory by indicating a single component--the absolute address in the second or third byte of the instruction in one of the register pairs or in the stack. This method of addressing is quite satisfactory for most applied problems when the programs are arranged by fixed, previously determined addresses. However, when realizing complex systems that dynamically distribute the memory resources among program components, the deficiencies of the indicated method of addressing are revealed. This is explained by the problems arising during loading and automatic connection of individual modules into a unified program, development of subroutine libraries, development of position-independent programs and in all other cases when the absolute program addresses cannot be indicated beforehand.

The problem of program relocation is solved in large and minicomputers by apparatus formation of effective addresses in the form of the sum of several components, for example, the contents of the base and index registers and resetting, which considerably simplifies adjustment of the program module for performance in the required absolute addresses.

One of the methods of shifting program modules in microcomputers based on the K580IK80 microprocessor is correction of the absolute addresses of the corresponding instructions of the program to be relocated. The operations performed in this case are largely analogous to operations in correction of

address constants during adjustment of program modules in large and minicomputers. The differences include the fact that not only the address constants but also the address parts of the control transfer instructions, subroutine call and so on are corrected when using microcomputers based on the K580IK80 microprocessor. This results in an increase of facility modules due to significant expansion of the relocation dictionary.

Another method of program relocation for microcomputers based on the K580IK80 microprocessor inculdes formation of the effective address through programming by addition of several components, which can be accomplished by using the instruction for adding the contents of DAD register pairs that load the result into the HL register pair. Control transfer by the formed effective address can be achieved by using indirect addressing instructions.

We shall subsequently assume that the effective address consists of two components--a base and shift. This does not affect the essence of the method under consideration, whereas formation of the effective address is simplified.

A program that adds the components of the effective address can be included in the text of the initial program as a macroinstruction or can be summoned as a procedure. Shifting is controlled as a macroinstruction parameter (procedure). The base can be given by the following methods: the contents of the instruction counter is used as the base for the first of them and the base address is stored in the memory or the register pair of the microprocessor by the second.

The main advantage of the first method includes the fact that it permits one to create position-independent programs. The contents of the instruction counter become accessible for calculations in the K580IK80 microprocessor only upon execution of subroutine call instructions by absolute address or second startup instructions. In both cases the procedure of calculating the effective address must be arranged for some fixed addresses to guarantee position independence.

It follows from the given data that macroinstructions occupy two or three times more memory and require three-five times more cycles for execution than the corresponding instructions of the microprocessor. Taking into account that the programs for the K580IK80 microprocessor contain an average of no more than 20 percent transfer instructions with respect to the absolute address, the use of the considered microinstructions increases the volume of programs no more than 1.2-1.4-fold and the execution time 1.4-1.8-fold.

Comparing the considered methods of program relocation of microcomputers based on the K580IK80 microprocessor, one may note the following.

The main advantage of the program relocation method by correction of absolute addresses is that it has no effect on the volume and speed of the program to be relocated. All expenditures related to relocation occur in the phase of preparing the programs for execution. However, this places higher reuqirements on the systems programs since the structure is complicated and the volume of the entity files is increased. The given method can be realized more fully

and effectively when using a sufficiently high-speed high-capacity external memory (for example, NMD [magnetic disk store]).

At the same time programs whose relocation is guaranteed by using the considered macroinstructions, in view of the essentially simpler structure of the entity module permitted by them, may guarantee more efficient use of the external memory, which permits the use of papertape carriers. Moreover, the methods of relocation when using the considered macroinstructions can be used with sufficiently simple operating systems. Thus, for example, the relocation programs can be assembled by generating an absolute entity code. These assemblers (resident and cross-over) have now become most widely distributed for microcomputers based on BIS [large integrated circuit] of series K580, produced by Soviet industry.

The capability of relating the time expenditures connected to program relocation to the phase of their preparation for execution is an advantage of the method of address correction in those cases when no dynamic program relocation is required. This method can also be used when the time expenditures for relocation are considerably less than the time of program execution. In turn, the method based on program calculation of the effective address permits one to achieve a definite time advantage if the time of program adjustment by address correction is comparable to the time of execution and cannot be eliminated from the total functioning time of the system.

Despite the fact that there is no hardware in the K580IK80 microprocessor that guarantees formation of the effective addrees in the form of the sum of several components, the problem of program module relocation can be solved by programming using one of the considered methods. Depeding on the specific requirements on the system, the capacity of its main memory, the capacity and speed of the external memory, the structure of the programs and the dynamic characteristics of their functioning, one or another method of realizing relocated programs can be selected that guarantees an optimum ratio between the capacity of the occupied memory, productivity and cost of developing the programs.

Let us note in conclusion that the considered methods of realizing program relocation were used in development of the operating system for the Elektronika K1-10 microcomputer, whose composition includes a debugger designed for automation of the user program debugging process. With regard to the fact that the debugger is placed at the end of the main memory to make available a continuous address field to the user regardless of memory capacity contained in the set of a specific modification of microcomputers, it should be a relocatable program. The specifics of debugging includes execution of one or another procedures during execution of each instruction of the program to be debugged.

The requirement of operational debugging determined selection of the method of relocating a given program--correction of the absolute instruction addresses. A loader that operates with relocation dictionary is used to load the debugger. For conveience of utilization, the loader is realized a self-relocated program loaded in any free section of the memory. The operating time of the loader

is not a critical parameter and the means of correcting the addresses are found in the loader and may not be used; therefore the loader itself is realized by means of the considered macroinstructions by the second method of base control.

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PROBLEM-ORIENTED DEVICES AND PRODUCTION PROCESS CONTROL LANGUAGE STRUCTURES

Kiev UPRAVLYAYUSHCHIYE SISTEMY I MASHINY in Russian No 3, May-Jun 82 (manuscript received 18 May 81, after revision 7 Sep 81) pp 72-76

[Excerpts from article by senior scientific associate Tat'yana Nikolayevna Yegorova and Candidate of Technical Sciences Yuriy Nikolayevich Kotel'nikov, Moscow]

[Excerpts] Introduct. KAUT-80 (Verification, analysis and control of technology, implemented in 1980) problem-oriented language was created mainly to describe the modes of controlling vacuum production processes located at enterprises of the electronics industry. Vacuum production processes have response on the order of seconds and the absence of complex computer functions and a large variety of control strategies are typical for them. Conversion from control minicomputers to microcomputers and microprocessors require the development of a new programming automation system (SAP) on the basis of a high-level input language. It is known that the use of a special language not over loaded with surplus devices enhances the effectiveness of applied programs and considerably reduces expenditures for production of them. Moreover, the simplicity and problem orientation of the language permit the recruitment of specialist-technicians have no skills of professional programming to development of control programs.

A large part of the properties of KAUT-80 language is typical for any sequential programming language [1]. This is natural since even complex control and operating systems consist of processes which in themselves are quite sequential. KAUT-80 contains a sufficient set of designs that guarantee calculations and program control, including control transfer, condition and cycle operators and also a set of specialized devices required to describe the process of real-time control of the production facility.

KAUT-80 problem-oriented language has the following properties:

--the initial program is an easily readable text in Russian language. The names introduced by the programmer are not limited in length and may reflect the physical meaning of the variable being described;

--the numbers with which the program operates can be represented not only in octal and decimal number systems, but in volts as well, which facilitates

working with actuating components and sensors installed on the control facility;

--description of equipment (sensors and actuating components) is reduced to naming the communications channels between the production facility and the control microcomputer, which relieves the input language of inconvenient and cumbersome means of describing external devices;

--the modular principle, which includes separation of the initial problem into specific constituent parts, is used extensively. The production program contains the aggregate of descriptions of operations, each of which is programmed and debugged independently to a considerable degree and can be used in assembly of complete production programs;

--there are multiprogramming devices that permit one to control parallel and asynchronous completion of the required number of operations;

--the language structures are simple and single-valued. The names of the operators take into account the specifics of describing the production processes.

The experience of using the KAUT language developed by the same collective at the beginning of the 1970s [4] for group control of facilities and oriented toward minicomputers was taken into account in developing the new language. Those deficiencies of KAUT language such as lack of development of means of changing the method of control, the rigid restriction of the number of operations performed in parallel and the considerable laboriousness of accompaniment and correction of applied programs have been eliminated in KAUT-80 language. Main attention was devoted in development of the problem-oriented high-level language to problems of reliability, specifically, the uniqueness of the language structures, simplicity and accessibility of its exploitation by a rather wide range of specialists in ASUTP [Automated production process control system]. The main advantage of KAUT-80 language, which distinguishes it from known Soviet process control languages [4-6], consists in the capability of modular design of production programs. The modular principle of the language simplifies the programming technology, permits one to develop and accumulate a library of applied program modules, upon accumulation of which programming of production processes can be reduced to writing "linking" operations that guarantee interaction of typical production operations.

KAUT-80 language is included in the programming automation system of the same name [7], which includes the following components:

--a one-way compiler that generates the real code of the Elektronika-60 control microcomputer in dialogue mode. The compiler automatically formulates the operations and functions in the form of independent modules supplied with the necessary information for cmmunication with other modules of the KAUT program.;

--a composer that combines individual modules into a unified control program;

--an operating system that guarantees real-time fulfillment of the control program at the control facility.

All components of the KAUT-80 SAP are realized on the Elektronika-60 control microcomputer with memory capacity of 8K 16-digit words.

A number of production process control programs for manufacture and aging of electrovacuum devices and various types of etching and spraying processes distributed throughout the electronics industry has been developed in KAUT-80 language. The volume of applied programs produced by using the KAUT-80 SAP comprises approximately 2K 16-digit words of read-only memory and 2K 16-digit words of main memory for the variable file.

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REALIZATION OF SUBSET OF IML LANGUAGE FOR ICAM-10 AUTONOMOUS CRATE CONTROLLER

Novosibirsk AVTOMETRIYA in Russian No 2, Mar-Apr 82 (manuscript received 10 Apr 80, revised version received 2 Dec 80) pp 83-85

[Article by M. N. Bukharov, V. M. Vukolikov and Ye. V. Pankrats, Moscow]

[Excerpts] Introduction. One of the important methods of accelerating the development of experiment automation systems based on CAMAC equipment is the use of standardized programming languages, which permits not only a reduction of the periods of preparing the software of these systems but also guarantees independence of the developed programs of the types of crate controllers used. According to this, the ESONE Committee worked out and standardized several levels of software to control the CAMAC equipment. Realization of the subset of one of these languages--intermediate level CAMAC-language IML [1, 2] for the ICAM-10 autonomous crate controller [3] designed on the basis of the INTEL-8080 microprocessor, is described in the article.

Programming of CAMAC instructions for the INTEL-8080 microprocessor. The ICAM-10 autonomous crate controller is structurally made in the form of a CAMAC module with built-in INTEL-8080 microprocessor. A description of the controller is presented in [3].

Let us consider in more detail the operating principle of the CAMAC page. The CAMAC page is 1 K 24-digit words. The addresses of these memory words are virtual with respect to the microprocessor and are used only to start the CAMAC cycle for data transmission between the CAMAC page and the module registers. The microprocessor has access to each of three bytes of the 24-digit word of the CAMAC page.

The addresses of the module registers in the crate and the CAMAC function form the virtual CAMAC-memory with C000-FFFF addresses.

The ICAM-10 autonomous controller has eight interrupt levels: four CAMAC-levels and four systems levels. The interrupts can be masked by using a common mask, an individual mask to each interrupt level and CAMAC instructions for masking L-signals.

Programming of CAMAC instructions in the ICAM-10 autonomous controller reduces to use of standard instructions of the INTEL-8080 microprocessor, transmitted to the special virtual memory.

Conclusions. The use of the subset of IML language described above facilitates writing and debugging of programs and their use by other programmers, which permits a reduction of the period of designing the software for control of CAMAC equipment. It must be noted that creation of IML language for Soviet autonomous controllers, designed on the basis of the K580 microprocessor set, is considerably facilitated if one uses the described realization.

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UPGRADING OF COMPUTER CENTER FROM WESTERN TO SOVIET COMPUTERS

Moscow VODNYY TRANSPORT in Russian 10 Jul 82 p 4

[Article by I. Ivanov: "The All-Seeing Eye of Computers"]

[Excerpts] A routine launch of the Cosmos-1383 artificial satellite occurred in the Soviet Union. Scientific apparatus for continuation of space research and also experimental equipment designed to process systems for determining the locations of ships and aircraft in distress were installed onboard the satellite.

The beginning of the last phase of tests of the ship and aircraft emergency search system (KOSPAS) is linked to this launch. The idea of this experiment occurred about 50 years ago and was developed on the Soviet side by Minmorflot [Ministry of the Maritime Fleet]. The American NASA, the Canadian Department of Communications and the French KNES [expansion unknown] participate in the foreign part of the project, which is called SARSAT.

Operation of the system includes the fact that a ship or aircraft in distress drops a radio buoy, the signals from which the satellite intercepts and relays them to special information receiving stations (they will be located at Moscow, Arkhangel'sk and Vladivostok in the USSR). The signals are then processed by computer at the National Center of the KOSPAS-SARSAT System and are transmitted to the search and rescue services. According to the calculations of scientists, no more than four hours should pass from the moment a buoy is dropped from a sinking ship until instructions are received by the rescuers.

The main difference of KOSPAS from the similar INMARSAT system, which has been reported frequently by VODNYY TRANSPORT, is that information on the type of ship, the number of crew members and so on need not now be included in the radio buoy at the moment of distress--it has been entered earlier and the coordinates of the buoy will be determined by the satellite. In preliminary tests it was detected from an orbit with accuracy up to 1 kilometer. That is, seamen in an extreme emergency situation do not have to do anything: everything is clearly done automatically for them. It is assumed that the KOSPAS-SARSAT system will be put into operation within a year to a year and a half.

As already indicated, data on a sinking ship are transmitted from a satellite to the national center, where they are processed on a computer. This center

is located at the Main Computer Center (GVTs), USSR Ministry of the Maritime Fleet, in the Soviet Union.

With regard to the fact that the computers of the GVTs of Minmorflot are faced with ever-newer tasks, including servicing of the KOSPAS-SARSAT program, the volume of work is being increased. The obsolete English, West German and French computer equipment of the center now in operation will soon be replaced by fourth generation computers of the International Unified System of CEMA with more powerful main memory and higher speed.

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PATENT INFORMATION RETRIEVAL SYSTEM

Tallinn SOVETSKAYA ESTONIYA in Russian 26 May 82 p 3

[Article: "Information Systems Are Being Automated"]

[Text] Users of the Val'ter automated information system, developed in Estonia by the Scientific Research Institute of Scientific and Technical Information and Technical and Economic Research, will have access to the patent information of 60 countries. The fifth conference of information workers of the Estonian SSR, opened on 25 May 1982 in Tallinn, is devoted to further development and improvement of automated information systems.

The Val'ter information system has already proved itself as an excellent assistant to specialists of practically all sectors of science and the national economy of the republic. However, not only the current information which Val'ter provides but also data on the investigations of years past is required to guarantee acceleration of scientific and technical progress in the republic. The so-called retroinformation system has been created for this. The joint development of EstNIINTI [Estonian Scientific Research Institute of Scientific and Technical Information and Technical and Economic Research] and the Institute of Chemistry, Estonian SSR Academy of Sciences--Retrokhim--will become its first part. Making the necessary information available to workers involved in implementation of complex scientific and technical programs directed toward intensification of industry and agriculture is of important significance in solving the problems of the information system during the 11th Five-Year Plan.

A solemn meeting devoted to the 25th Anniversary of the System of Scientific and Technical Information in the Estonian SSR, was held on the opening day of the conference. The Deputy Chairman of the Estonian SSR Council of Ministers, Chairman of the Estonian SSR Gosplan G. Tynspoet participated in it.

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MANUFACTURE OF MACHINE TOOLS WITH NUMERICAL PROGRAM CONTROL REPORTED

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 13 Mar 82 p 2

[Article by N. Ordinyan: "Machine Tool With Computer"]

[Excerpt] Serial production of electrocorrosion-cutting machines of model 4732FZ, developed by specialists of ENIMS [Experimental Scientific Research Institute of Metal-Cutting Machine Tools], has been organized at the Kirovakan Precision Machine Tool Plant.

The new machine tool is equipped with a numerical program control device based on the Elektronika-60 microcomputer. Information is entered from papertape. Besides this, the operator servicing the new machine tool can formulate a new machine program directly on the machine tool by means of a keyboard on the panel of the ChPU [numerical program control] device. The presence of a display in the device facilitates program correction. The program for machining several parts can be stored in the main memory of the ChPU device.

The microcomputer has expanded the production functions of the machine tool, has provided three-coordinate machining, has realized the principle of self-adjusting control of the machining mode and has increased cutting speed.

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LIST OF ARTICLES ON RAILROAD AUTOMATION

Moscow ZHELEZNODOROZHNYY TRANSPORT in Russian No 3, Mar 82 p 1

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RAILROAD AUTOMATED CONTROL SYSTEM HARDWARE

Moscow ZHELEZNODOROZHNYY TRANSPORT in Russian No 3, Mar 82 pp 47-48

[Article by V.K. Romanenok, chief engineer, railroad computing center, and V.Ye. Beloshevskiy, chief, electronics division, Minsk: "System Hardware"]

[Text] The uninterrupted operation of an automated system for controlling a railroad depends on proper selection of the hardware complex and on the structural design and proper selection of additional equipment.

Already at the first stage of introduction of an ASU [automated control system] in the Belorussian Railroad contradictions arose between the increasing flow of information and the capabilities of the computer. The computer hardware complex available clearly did not satisfy the heightened requirements for processing data and transmitting it to the user. It was necessary to increase the capacity of the "Minsk-32" computer by improving the characteristics of external memories, since at this stage the key indicators--throughput and reliability of the storage of incoming data--had not been fulfilled.

Improvement of the characteristics of individual units did not always make it possible to solve the first main problem--increasing the computer's throughput. Therefore, in designing the computer complex it was necessary to increase its capacity by uniting two "Minsk-32" computers into a unified system.

The second problem, which creation of the computer complex (VK) solved, was relieving the central processor of one computer from processing of data. The other computer makes possible the input/output of information arriving from communications lines. An RV-7/M-32 magnetic drum unit with a capacity of 1 Mbyte and mean access time of 40 ms was chosen as an external memory for creating a common memory field for the two computers.

New equipment, including a YeS-5551, YeS-5052 and AD-3032, was used at the next stage of development of the computer complex. The use of a YeS-5551 magnetic disk 2-channel control switch made it possible to create a VK-32 computer complex out of two computers and then to accomplish the systematic transition to higher-capacity computers of the Unified System.

The VK-32 complex consists of two "Minsk-32" central processors, two AD-2032 adapters, a YeS-5551 magnetic disk storage control unit, and two YeS-5052

storages. The computer can interchange information with the memory (ZU) of a YeS [Unified Series] computer by means of the AD-2032 adapter, which interprets and runs for the YeS computer's memory programs assigned to the "Minsk-32" computer.

The operation of the complex can be represented in the following manner. One of the "Minsk-32" processors sends a request for data interchange, which via the AD-2032 adapter enters the disk storage control unit (UU NMD). Here an analysis is made of the possibility of fulfilling the request and if the control unit at the moment of time in question is not occupied with fulfilling a request from the other processor then it is permitted without delay. Otherwise the appropriate service information enters the computer and is analyzed by interchange routines. Any "Minsk-32" computer operating system--KOORDINATOR, BAD, etc.--can be used as the complex's operating system (OS).

Thus, the 2-computer complex created made possible reliability of data storage, high throughput and connection to the VK-32 of any YeS computer.

In converting to the higher-throughput YeS-1035 computer it was necessary to design an electronic switch for coupling with YeS-5052 magnetic disks. Thus, the possibility appeared of receiving in the YeS-1035 computer data from the VK-32 data base and then of processing it. This principle is used in designing a dynamic model of a railroad. As a result of the calculations 24-hour and cumulative forms GO-1, GO-2, GO-3 and DO-15 are put out for each station of the railroad individually.

At the present time a new computing complex is being created on the basis of two YeS-1035 computers. Work is being done on implementation of intercomputer interchange by means of a "channel-channel" adapter (AKK) with direct control and creation of a common disk storage field for the YeS-1035 and "Minsk-32" computers. The possibility has again appeared of using a data base in intercomputer interchange. At any moment of time the input/output computer ("satellite") can send a signal to the "processor" computer for output of the required form (information) followed by its transmission to the user.

Convinced by the operating experience of other computing centers that with considerable amounts of data to be received on punched tape a large number of teleprinters is required but that reliability remains low, we decided to develop a data teleprocessing system and to make possible the input of messages from communications channels into the computer without preparation of punched tape data media. The organization of teleprocessing made it necessary to solve a number of technical and organization problems, such as installing a multiplexer (MPD) and data transmission equipment (APD), creating data teleprocessing and transmission software, etc. Two sets of "Minsk-1560" equipment are used in the computing center as a data transmission multiplexer.

The use of equipment for direct entry of data into the computer made it possible to increase drastically its reliability on account of elimination of the intermediate punched tape medium, to reduce the number of teleprinters in the computing center, to release the shift electromechanical personnel in the communications department and part of the shift telegraphists, and to implement the principle of

using a second-generation computer in the interaction mode. In addition, technological capabilities have been considerably expanded in the computing center and on the line with regard to the reception, processing and transmission of data.

However, in the operating process inadequate design development of the "Minsk-1560" data transmission multiplexer was evidenced, consisting in the fact that it does not make it possible to link with many peripheral units, especially YeS-computer units. Therefore, at the railroad's computing center a number of developments were carried out relating to linking available peripheral units with the "Minsk-1560" data transmission multiplexer.

First a circuit was designed for linking the data transmission multiplexer with four "Akkord-1200PP" data transmission unit subsets, making it possible to accomplish the input of data into the computer according to a common algorithm for telegraph and telephone communications channels. At the present time seven "Akkord-1200PP" data transmission units are connected to the data transmission multiplexer. For the purpose of producing documents and for fuller utilization of the technical capabilities of the data transmission equipment, at the railroad's computing center the "Akkord-1200PP" equipment has been linked with a YeS-computer "Videoton-343" printer, which has currently been replaced by a "DZM-180."

Linking the "Minsk-1560" data transmission multiplexer with a "Videoton-340" display made it possible to utilize new capabilities for expansion of man-computer interaction. This made it possible to transmit messages through telegraph channels or through assigned communications channels at a speed of 150 bauds (this speed is determined by the internal operating cycle of the "Minsk-1560" data transmission multiplexer). This speed can be increased to 1200 bauds by reducing the number of telegraph channels.

Basically all the circuits developed at the railroad's computing center are executed with standard elements (units) of the "Minsk-32" computer and "Minsk-1560" data transmission multiplexer. For the purpose of linking the "Akkord-1200PP" data transmission equipment with the "Minsk-1560" data transmission multiplexer, standard signals are used for interchange of data with terminal equipment: The data transmission equipment operates through an assigned 4-wire communications channel in the automatic signaling mode, i.e., only the duty power is switched on. As a result of technical modifications in the technological process only a single computing center worker or user began to take part in transmission of data. Computing center telegraphists intervene only in failure situations in the process of inputing information into the computer.

At the present time a data reception and transmission system has been introduced at the railroad computing center which uses magnetic tape (ML) as a data medium. For this purpose development work has been carried out on linking YeS-9002 magnetic tape data preparation units with the TA-600 data transmission equipment. As a result of linking them the possibility has appeared of widely using this complex in working with second- and third-generation computers. For second-generation computers a method of software and hardware compatibility has been introduced for the magnetic tape of the "Minsk-32" computer and the YeS-9002 unit, a tape input program has been prepared for the "Minsk-32" computer and the YeS-9002 unit

has been modernized for the purpose of reading this tape with output of the results of solutions to a user communication channel.

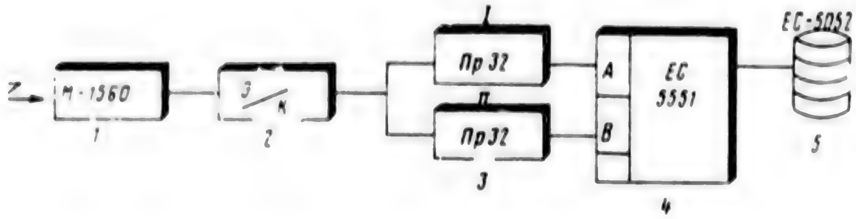

Figure 1. Structural Diagram of VK-32 Computer Complex: 1--"Minsk-1560" unit; 2--electronic switch; 3--"Minsk-32" processor; 4--YeS-5551 disk storage control unit (UU NMD); 5--YeS-5052 magnetic disks

A very simple input program which writes received information onto magnetic tape without any kind of check was developed as early as 1973 on the basis of standard software. Simultaneously with the development of this program, together with associates of the Scientific Research Institute of Computers, was begun the development of an input program with a logical check of source data and the issuing of an "acknowledgement" for reception or of numbers of errors with a printout of erroneous lines.

With the obtainment of magnetic disks and the "keeping" in the computer's memory of full-scale lists for all trains, it was necessary to create a magnetic disk data base for the "Minsk-32" computer. The computing center's associates developed software for operating with the magnetic disks, which has been handed over to a number of other railroads and is being introduced at other enterprises and in republic ministries.

For the purpose of organizing rapid retrieval of data messages on a magnetic disk (without which it would have been impossible to introduce the output of working documents in real time), message "cataloguing" programs were developed (by number, point of destination, belonging of a transfer station to a railroad division, etc.) and programs for accessing through catalogues. This has made it possible to put out working documents for 17 stations of the railroad, to write solutions for problems run in the data call mode onto magnetic disks and to output them to users of any level onto a "Videoton-340" or "Akkord-1200PP" teleprinter interfaced both with punched tape and with a "DZM-180." For the purpose of relieving telegraph channels, a program check has been introduced which "prohibits" users having two subsets of "Akkord-1200PP" equipment from working on the teleprinter.

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RAILROAD DATA TRANSMISSION SYSTEM

Moscow ZHELEZNODOROZHNYY TRANSPORT in Russian No 3, Mar 82 pp 49-51

[Article by N.S. Zablotskiy, chief, signaling and communications service, and O.F. Aniskevich, chief, stationary and cable line equipment division, railroad computing center, Minsk]

[Text] For the purpose of providing efficient d·ta processing and information service to users of the automated control system and of guaranteeing the high quality of information input into the computer, in the Belorussian Railroad a great amount of work is being done on enhancement and construction of data transmission systems. At the first stage of creation of the ASU [automated control system], in keeping with the planning and estimating documentation developed, the TT-17P 17-channel telegraph equipment was installed at large stations of the railroad, and the V-3-3 telephone equipment multiplexed with P-314M telegraph communications equipment at key intermediate stations. During the years of the Ninth Five-Year Plan period a total of 2380 channel-km of telegraph connections, which made it possible to transmit data to the railroad's computing center, were set up on the railroad.

At the first stage the data transmission system included only switched telegraph service. Four STA-2MF telegraph sets for data preparation and 10 T-63 teleprinters connected to the railroad administration's communication network were installed at the computing center.

Introduction of the first phase of the ASU heightened the requirements for the data transmission system with regard to the reliability, completeness and timeliness of transmitted data. The development of a teleprocessing system--the mos important component of the ASU--was begun. This system was developed for the "Minsk-1560" computer. A total of 20 switched telegraph lines were connected to the computer. In addition, the railroad's communication engineers provided for the possibility of connecting to the "Minsk-1560" unit three "Videoton-340" displays through a telegraph interface and began work on the design of an automated data transmission system based on the medium-speed "Akkord-1200PP" and TA-600 equipment (APD [data transmission equipment]) and 4-wire assigned telephone channels.

The computing center's communications department engineers completed the development and performed the connection of four subsets of "Akkord-1200PP" equipment

to the "Minsk-1560" unit in the automatic interaction mode. The "Akkord-1200PP" equipment was switched manually, using a switching field for six of the most important stations of the railroad. Later an automatic switchboard was developed and created for 4-wire telephone channels, based on ShI-25 step-by-step switches with an electronic control circuit, which switched 10 telephone channels to four "Akkord-1200PP" data transmission equipment subsets installed at the railroad computing center.

Personnel of the railroad's signaling and communications division laboratory together with specialists of the computing center solved the problem of connecting, on individual routes, to a single channel several pieces of data transmission equipment installed at a single center. For this purpose a unit was developed for switching a telephone channel to one of four parties at a center by means of voice-frequency selective ringing receivers (PTIV's). With an outgoing connection (from the computing center) switching of the channel to the required party and switching of the equipment to the data transmission mode are accomplished by a combination of voice frequencies from the switchboard. With an incoming connection a channel is "occupied" by one of the parties in the "competition" mode. Each party has an indication that the line is busy.

In connection with the fact that for the "Akkord-1200PP" equipment the assignment of telephone lines is required and taking into account the difficulties in providing communications cable, the signaling and communications service made the decision to develop communications lines by hanging color-coded networks and multiplexing them with 3- and 12-channel equipment. During the years of the 10th Five-Year Plan period the manpower of the signaling and communications divisions hung an additional 5580 wire-km of color-coded networks and organized an additional 32,682 channel-km of telephone service. This made it possible to assign individual 4-wire telephone channels for connecting data transmission equipment and to develop a data transmission network for medium-speed equipment.

By 1977 the railroad administration, divisions and all sorting and large freight yards had been furnished with "Akkord-1200PP" and TA-600 data transmission equipment, DZM-180 printers and "Videoton-343"'s. Circuits for linking the data transmission equipment to the printers were developed and executed by specialists of the computing center. The combination of technological measures, improvement of the software and work on organizing a data transmission network based on a teleprocessing system made it possible to raise the level of reliability and completeness of information on train operations.

In the same year at the computing center a quasi-electronic 4-wire telephone channel switchboard was developed and introduced which made possible an automatic incoming as well as outgoing (upon an instruction from the computer) connection. In addition to its main functions of line connection and switching equipment on, by means of this switchboard an indication is provided of the flow of data for input and output for each subset of data transmission equipment, as well as automatic signaling of delays and interruptions in operation of the computing complex. The switching element in the unit is an MKS 20 X 10 X 6 crossbar switch. The electronic control circuit is designed on the basis of standard elements of the 250 and 600 kHz complex of the "Minsk-32" computer.

The mode of an automatic outgoing connection upon an instruction from the computer was tested over several months in outputing sorting sheets and forecasting train formation for sorting yards. This mode demonstrated the insufficient efficiency of transmission of data from the computer. In this connection, at the railroad computing center a process and software were developed for outputing decisions and various documents upon request of the user in the interactive mode. In the request format the user indicates, in addition to digits for decisions and documents, the code in which data will be transmitted from the computer.

Simultaneously with the development of telephone communications channels and installation of the "Akkord-1200PP" equipment, great importance was attached to the development of telegraph communications for transmission of data through T-63 teleprinters. With this, in connection with the lack of automatic switching equipment at divisions and large stations, the replacement of manual telegraph sets with automatic was called for for the timely transmission of information.

In 1979 the automation of the telegraph service was fully completed on the railroad and AT-PS-PD automatic telegraph sets interconnected by means of telegraph channels were installed at all department communications stations. This made it possible to arrange for automatic output to a telegraph set through a standby channel with the "loss" of a channel on the main route. In addition, low-capacity type ATK-20 automatic telegraph sets connected to AT-PS-PD department sets were installed at the Grodno, Luninets, Polotsk and Kalinkovichi stations.

At the beginning of the 10th Five-Year Plan period for the first time a new telegraph set was introduced in the railroad for the transmission of digital data, of the TT-12 type with a USK-TT attachment developed by the Ministry of Railroads Central Signaling and Communications Administration Design Bureau, which makes it possible to assign telegraph channels at intermediate stations (which is very important for transmitting information from these stations directly to the railroad computing center). In recent years new communications centers have been constructed at 17 of the railroad's stations and the existing system has basically been created for transmission of data from 32 information concentration points (PKI's), furnished with double "Akkord-1200PP" data transmission equipment subsets and DZM-180 printers. In addition to this standby telegraph service has been provided. T-63 telegraph sets have been installed at the remaining PPI's [as published].

PKI's have been set up at sorting yards and large freight yards of the railroad. They concentrate information at a center and serve various management units of the station, sections with low-activity stations and enterprises of other departments. USSR Ministry of Communications teleprinters have been installed at PKI's for communication with senders and receivers, and in the railroad's administration for traffic control equipment, a TA-600 user station and DZM-180 and "Videoton-340" units. The "Videoton-340" display at this user station works with the computer in two modes: through a telegraph interface and through a printout interface via the TA-600 unit. "Videoton-340" displays have been installed also for managers.

At the Minsk-Tovarnyy station a "Videoton-340" display has been connected to a hump shunting automatic interlocking (GATs) unit, which makes it possible to sort trains according to a program obtained from the computer. The USSR Ministry of

Communications telegraph line is used for transmitting data on the arrival of trains with freight for various enterprises of the republic. These data are read out directly from the computer onto the teleprinters of individual ministries and departments.

At the computing center two user stations have been developed and introduced, consisting of a TA-600 data transmission unit, a YeS-9002 magnetic tape data preparation unit and a "Videoton-340" display with a recoding circuit for receiving and transmitting data. Magnetic tape is used as the information medium. Data are read out onto the display in transmission and reception. The user stations are connected via a switchboard to a 4-wire telephone channel and to a switched telephone line. They are used for transmitting and receiving data for tasks not included in the teleprocessing system (direct seat reservation tickets, calculations for transport of RTK [expansion unknown], handling the paperwork of form K00-4, etc.), as well as for communicating with the Ministry of Railroads Central Computing Center.

The "Minsk-32" computer has a small working storage and not too high speed, which limits the number of channels which can be connected and the system's carrying capacity. Therefore, for the purpose of improving the data transmission system's carrying capacity, on the railroad measures have been taken to eliminate non-productive occupancy of channels: Circuits have been developed and implemented for automatic time reading and for cutting off telegraph and telephone lines through which data have not been transmitted for 20 s.

At the present time the railroad automated system makes possible transmission of data through telephone channels at a speed of 1200 bits/s and through telegraph channels, of 50 bits/s and interchange of information with displays takes place at a speed of 150 bits/s. The system serves more than 50 users. The volume of input and output information in the railroad computing center's teleprocessing system equals, respectively, 3.5 million and more than 12 million characters per 24-hour period. About 90 percent of the volume of data is transmitted through telephone channels, which are occupied from 1 to 4 h per 24-h period. The total operating time for each of the seven data transmission units at the computing center is 13 h and the number of connections equals 700. The time for the system to "react" to a complicated message (commodity list for a train, messages regarding loading and unloading) is 12 to 15 s and for a request message, 1 s. With this reaction time with a considerable number of complicated messages, at "peak" hours the computer's "reaction" time can increase to 1 to 1.5 min. High reliability of the system is achieved by redundancy, improving the efficiency and working capacity of equipment and by a high degree of automation in the system.

Further development of the data transmission system requires considerable enlargement of communications channels. For this purpose the Leningrad Lenzheldorproyekt [expansion unknown] design and research institute has developed a data link project for the Belorussian Railroad and the signaling and communications service has designated measures to replace overhead communications lines with cable lines and to multiplex them with high-frequency equipment.

At the present time at the railroad computing center a combination of work is under way on converting the existing data transmission system to YeS [Unified Series] computers and on connecting to it new user stations based on microcomputers.

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RAILROAD INFORMATION CONCENTRATION POINTS: EQUIPMENT AND TASKS

Moscow ZHELEZNODOROZHNYY TRANSPORT in Russian No 3, Mar 82 pp 50-52

[Article by B.V. Yerokhovets, chief, terminal equipment department, railroad computing center, Minsk: "PKI's: Equipment and Tasks"]

[Text] Information concentration points (PKI's) and information points (IP's) have been set up on the railroad for the purpose of improving the data support for tasks of on-line control of the transportation process and for organizing interchange of information on trains, cars and freight.

The information concentration point is the main information subdivision on a railroad. Information concentration points acquire primary information in the service area, prepare and transmit to the computer source data messages and to operating personnel of stations and departments data involved in controlling the transportation process, and obtain from the computer the results of solutions and transmit them to users, and information from receivers regarding the arrival of cars and freight to be unloaded, and print out freight documents and requisitions and perform a number of other functions.

The PKI and IP staff includes specially assigned informant operators for transmitting information to receivers, planner operators, shunting controller operators, teleprinter room telegraphists and other personnel. The work of a department PKI is supervised by the deputy chief of the information traffic division, of a station PKI by the process engineer or deputy chief of the engineering office, and of an IP by a senior operator. Operations and procedural supervision of the work of a PKI is performed by the railroad computing center.

The hardware base of a PKI includes data preparation equipment (T-63 telegraph sets, automatic calculators of the "Zoyemtron" and "Iskra" types), data transmission and reception equipment (the "Akkord-1200PP" and TA-600 and printers of the "DZM-180" type and "Videoton-343"'s) and video terminals ("Videoton-340", etc.). Main and standby subsets of "Akkord-1200PP" data transmission equipment and DZM-180 printers have been installed at all PKI's of the railroad.

Information interchange between a PKI (IP) and the railroad computing center is carried out through assigned telephone and switched telegraph communications lines.

PKI users interact with the computing center only through telephone channels, and information points through telephone and telegraph communications channels.

The information transmitted by a station PKI to the railroad computing center amounts to approximately 200,000 decimal characters per 24-hour period. Each 24-hour period a station receives in the form of finished solutions of various kinds about 600,000 decimal characters. The shunting controller of a station is able by means of a "Videoton-340" video terminal to obtain by request in real time information on trains arriving at the station. The hump attendant uses the video terminal in sorting trains and controlling the hump automatic equipment.

The system for on-line control of the transportation process provides for the arrival from concentration points to the railroad computing center of more than 20 kinds of source messages. Any message can be corrected both according to the computer's requirements and by desire of the user. A source message is prepared on T-63 telegraph sets, as well as on the "Iskra" and "Zoyemtron" automatic bookkeeping machines. It is transmitted via the data transmission equipment input unit to the railroad computing center or to another of the railroad's engineering stations. The computer analyzes the message received and, if it is correct, issues an "acknowledgement" of quality. In detection of an error the computer puts out information regarding the type of error and the user immediately corrects it. The personnel of stations and departments are able to obtain decisions from the computer for purposes of on-line control, using requests for output of a ready decision, for arranging for calculation and outputing decisions in the on-line mode, and for outputing working documents for a group of trains.

At the present time PKI's and information points are furnished basically with second-generation receiving and transmitting equipment and DZM-180's. Data are prepared on T-63 telegraph sets. The presence of an intermediate medium (punched tape) influences the quality of the source data, results in involuntary loading of channels and computers and reduces labor productivity.

In our opinion, with the state of the art of the development of computer technology many functions of data interchange with remote users which are performed at the present time by a central processor can be implemented by means of intelligent equipment and peripheral user stations. On the railroad experience has been gained in the use of the "Zoyemtron" and "Iskra" electronic automatic bookkeeping machines (EBM's). At the Brest Junction PKI a "Zoyemtron" EBM is used to produce a data medium in the process of preparing source data. "Iskra-554" EBM's have been introduced at the Minsk-Tovarnyy station. This machine meets many requirements to be imposed on the equipment of a future PKI. The computer programming language, oriented toward writing multicolumn documents, combines rather extensive capabilities and at the same time is extremely simple and accessible even to a telegraph operator.

At the railroad computing center software has been created for solving on EBM's problems in outputing a commodity list for a train to be dispatched, information on the situation in the arrival depot and on tracks of the sorting yard, and in outputing the majority of working forms for station personnel on the basis of VTs-11 and VTs-33 forms obtained from the railroad computing center. Thus, by means of this machine it is already possible to perform a certain range of tasks

solved on other railroads on a YeS-1010 computer, etc., installed at large stations.

It must be mentioned that the "Iskra-554" EBM has a long list of important disadvantages which prevent its broad application for automating the work of concentration points. Chief among these are the absence of a link with a communications channel, operation in the single-program mode, and the lack of remote consoles. The reliability of round-the-clock operation under the complicated conditions of a station will be revealed in the process of using these machines.

In the current year "Iskra-555" EBM's and microcomputers are being delivered to the railroad. Program debugging of this equipment, implemented either by microprogram or through a program written in the memory, ensures their functional "flexibility" and adaptability to the requirements of various users of the data teleprocessing system. There is the real possibility of concentrating the "memory" in a single place for several users, of performing the preprocessing of information (chiefly in order to compress it) and of solving a number of station problems, which will make it possible to utilize even better the communications channels and resources of the computer of the railroad computing center.

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RAILROAD AUTOMATED CONTROL SYSTEM NEW HARDWARE

Moscow ZHELEZNODOROZHNYY TRANSPORT in Russian No 3, Mar 82 pp 53-55

[Article by V.I. Pankratov, director, VNIIZhT [All-Union Scientific Research Institute of Railway Transportation] Computing Network Laboratory, candidate of technical sciences]

[Text] Efficient functioning of the Belorussian Railroad ASU [Automated Control System] would be impossible without a sufficiently developed complex of hardware, which must ensure operation of the system in real time. This is responsible for the strict requirements for message delivery and data processing time and for the need for high throughput and reliability of all of the system's hardware in the process of operation.

Articles by railroad personnel published in this journal elucidating questions relating to the design of the computing center's computer complex, the data transmission system, organization of the work of information concentration points, as well as the development of a data teleprocessing system, show that standard hardware used in the operation of the computing centers of other railroads, also, has chiefly found an application in the Belorussian Railroad ASU. This includes primarily T-63 teleprinters and "Akkord-1200PP" data transmission equipment (APD), hardware for organizing assigned and switched telegraph and telephone communications channels and the "Minsk-1560" data transmission multiplexer for directly linking channels with the "Minsk-32" computer. "Videoton-340" displays, teleprinters and "DZM-180" printers interfaced with medium-speed data transmission equipment are chiefly used as equipment for outputing processing results.

Comprising an exception is the hardware developed by railroad computing center specialists making possible operation of the system in assigned modes. This includes equipment for the multicomputer organization of "Minsk-32" computers at the railroad computing center, a special switchboard for 4-wire telephone communications channels, circuits for modernizing the "Minsk-1560" and also a number of other pieces of equipment.

Expansion of the range of on-line control problems to be solved at the computing center and the growth in the flow of result data used directly for organizational and technical control of the transportation process have imposed new requirements also on the system's hardware. They must be aimed at improving the throughput and reliability of acquisition hardware, improving the quality of data transmission

and processing, increasing the carrying capacity of the data transmission system, automating processes of data acquisition with the simultaneous preparation of transportation documents, and at the distribution of computer facilities over the railroad's area with the installation of microcomputers and intelligent terminals directly at control sites. Fulfillment of these requirements is impossible without the introduction in the railroad of new equipment, already supplied for railroad transportation or planned in the near future. In addition, industry has developed a number of pieces of equipment which can also find an effective application in the ASU of the Belorussian and other railroads.

First of all, taking into account the broad nature of the use of telegraph communications for data transmission, of the number of promising pieces of hardware it is a good idea to discuss in greater detail the FKG-1001 unit for improving the reliability of data and the F-1100 electronic teleprinter (produced in the GDR). As compared with the FKG-T50 instrument produced earlier, the new FKG-1001 unit has a number of important advantages and makes possible transmission and reception of information in the unprotected and protected telegraph modes, automatic pickup of information in the absence of the operator (with protection from unauthorized access), transmission of information from the keyboard of a teleprinter in the protected mode, and interchange of information through switched telegraph communications channels with a YeS [Unified System] computer via an MPD-1 (YeS-8410) multiplexer equipped with a group unit for protection from errors, the "TYeTA-1250".

In combination with an F-1100 electronic teleprinter, which has high reliability and a data transmission speed of 100 bauds, the FKG-1001 unit makes possible probability of the appearance of an undetected error of not greater than 10^{-6}. This is necessary for transmission of information prepared by an operator with a high degree of reliability, or of information on which heightened requirements are imposed.

One of the most complicated technical problems is automation of the acquisition and preparation of data. Work on the selection and development of a technology for combined preparation of primary sources and machine media by means of automatic computers is under way in the Belorussian Railroad, using EBM's [electronic accounting machines] of the "Iskra-554" type.

The TAP-34 user stations (Hungarian People's Republic) and domestic SM-1800 microcomputers slated for delivery for railroad transportation are distinguished by broader functional capabilities and better technical characteristics. For example, the SM-1800 microcomputer has a word length of 8 bits, a speed of 100,000 to 500,000 operations per second (depending on the kind of operation), a RAM capacity of 64K bytes, a ROM capacity of 4K bytes and eight interrupt levels. In addition, the SM-1800 is furnished with hardware for linking with interfaces. Floppy disk storages, VTA-2000-3 video terminals, DZM-180 printers and tape cassette storages can be connected to this microcomputer as peripheral devices.

Modules for linking with interfaces make it possible to connect to the microcomputer telegraph communications lines and modems (or signal conversion devices having an output to a circuit for interchange between terminal equipment and the data transmission equipment--an S2 interface). When using a module for linking with a modem the data transmission speed in the asynchronous mode can equal 50, 100, 200, 600,

1200, 2400, 4800 and 9600 bits per second. The sufficiently developed software for the SM-1800, consisting of visual display, text editors, a translator from ASSEMBLER and programs serving libraries, makes it possible to use this computer for preparing data with the simultaneous performance of a number of computing operations.

User stations based on microprocessor equipment of the TAP-34, SM-1800 and VT-20 types (the latter having a replaceable disk storage with a capacity of 2 X 2.5M bytes, a double floppy disk with a capacity of 2 X 250K bytes and more developed software as compared with the TAP-34 and SM-1800) will make it possible to organize at peripheral stations of the Belorussian Railroad ASU and at line subdivisions (engineering and freight offices, depots, etc.) not only the automated acquisition and preparation of data, but also the solution of an entire range of local problems with the implementation of direct interchange of information through communications channels with the central computer complex of the railroad computing center.

Of great importance for further development of the railroad's ASU is the introduction of new and promising communications and data transmission hardware. One of the major problems here is automation of the work of PKI's [information concentration points], where it is still necessary to perform manually a considerable number of operations relating to acquisition of primary information from subdivisions of the service zone, the preparation and transmission to the computer of data messages, and also the preparation, receipt from the computer and transmission to operations personnel of data involved in control of the transportation process.

A considerable portion of these functions can be automated by using at PKI's modern message switching equipment based on small or mini- computers. As one of these pieces of equipment can be regarded the UVTK-KI equipment, designed for enabling interchange of data between ASVT-M [Modular Computer Hardware System], SM [International System of Small Computers] and YeS [Unified Series] computers and remote terminals through telephone and telegraph switched and assigned communications channels.

The structure of the UVTK-KI includes a central control unit based on an "Elektronika-60" microcomputer, a software-hardware complex interface (IPAK), adapters for linking with modems (AD1's) and teletypes (for a distance to 5 km) (AD2's), as well as adapters for remote linking with YeS and ASVT computer equipment and DM-500 and DM-2000 display modules for a distance of up to 1 km (AD3's). In addition, this equipment includes an adapter for linking with terminal equipment and data transmission equipment through an S3 interface, interface cards for a 2K interface, and a synchronous modem for physical communications lines and transmission speeds of up to 600 to 19,200 bits/s.

On the basis of a UVTK-KI it is also possible to implement programmable teleprocessing facilities, such as a teleprocessing processor (PTO), a "remote" concentrator and an intelligent user station (IAS). The teleprocessing processor serves up to four data transmission channels, as which can be used switched and assigned telegraph and telephone local and long-distance lines, as well as physical lines. It makes possible the transmission, "compression" and "restoration" of data and control of a connection in switched channels. The teleprocessing processor reduces messages to a unified format. The "remote" concentrator switches both

messages and communications channels and performs the functions of data transmission, buffering and routing of messages. The "intelligent" user station (terminal concentrator) makes it possible to work with teleprinters, displays, etc. The IAS implements acquisition and buffering of data from terminals, transmission of messages, unification of primary code and message formats, "compression" and "restoration" of data, and control of a connection in switched lines and performs bit-by-bit synchronous transmission of data making possible remote access to computers of the SM and YeS types and recodes MTK-2 codes into KOI-7 and KOI-8 and vice-versa, and receives and transmits data from remote teleprinters and nearby and remote computers and data transmission and concentration equipment and display modules.

Depending on the type of modem used, the UVTK-KI makes it possible to operate through switched and assigned telegraph communications lines at a speed of 50, 75, 100 and 200 bits/s, switched and assigned local and long-distance telephone lines at a speed of 600, 1200, 2400 and 4800 bits/s and physical lines at a speed of 1200, 2400, 4800, 9600 and 19,200 bits/s.

A structural diagram of the equipment used as a terminal concentrator is shown in fig 1. Here the "Elektronika-60" computer complex includes a central processor, a control unit, an additional 4K-word RAM, an intermediate ROM and a parallel interface. Two AD1 modem adapters are connected to the IPAK line, and AD2's and AD4's in the arbitrary set. The maximum number of AD2, AD3 and AD4 adapters must not exceed 14. Teleprinters are connected to the AD2 adapters through a 3- or 4-wire physical line, and display modules or a computer to the AD3 adapters through a 4-wire duplex line and TK2K interface cards. The maximum distance for teleprinters is 5 km and for display modules 1 km. The AD4 makes it possible to interface with a YeS computer, as well as to link with remote complexes via APD-MA's [data transmission devices].

In solving the problem of assigning communications channels for data transmission, the K-24T ("Astra") equipment for linking remote transportation users developed by the central headquarters design bureau and enterprises of the Ministry of the Communications Equipment Industry can be of great importance. It is designed for the operation of two communications systems through a 2-cable trunk. Each system occupies the frequency range of 12 to 108 kHz, in which 24 standard telephone channels are assigned (300 to 3400 Hz).

The system's channels are divided into two groups: The first group (1 to 13) is designed for communication of terminal stations and occupies the frequency band 12 to 60 kHz, and the second (13 to 24) is for separating any channel at intermediate stations and occupies the frequency band of 60 to 108 kHz.

For the wide-scale introduction of "Astra" equipment in railroads it is necessary to speed the development of cable trunk communications lines.

At the present time the team of the Belorussian Railroad Computing Center is doing a great amount of work on converting to processing of data on YeS computers. For the purpose of increasing the efficiency of this work and making it possible to obtain standard solutions for data teleprocessing, it is necessary to speed the entry into service in the Belorussian Railroad of the YeS-8410 data transmission

multiplexer received as the main data transmission multiplexer for the railroad system computing center for 1981-1985. This multiplexer can serve up to 32 communications channels with a total interchange speed of 19.2K bits/s and will make it possible to introduce a sufficiently efficient data teleprocessing system in the railroad with the later creation of a railroad message switching center based on a "communications" computer.

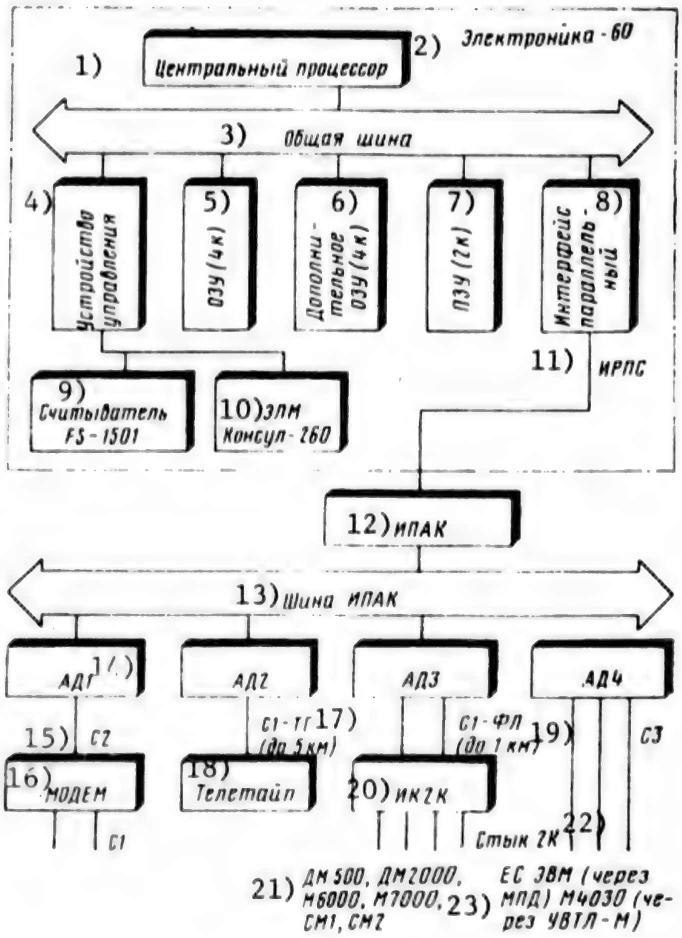

Figure 1. Structural Diagram of Terminal Concentrator Based on UVTK-KI Equipment

Key:

1. Central processor
2. "Elektronika-60"
3. Common line
4. Control unit
5. RAM
6. Additional RAM
7. ROM
8. Parallel interface
9. Reader
10. "Konsul-260" electronic typewriter
11. IRPS [expansion unknown]
12. IPAK [software-hardware complex interface]
13. IPAK line

[Key continued on following page]

14. AD1
15. S2
16. Modem
17. S1-TG [telegraph] (to 5 km)
18. Teleprinter
19. S1-FL [physical line] (to 1 km)
20. IK2K
21. DM-500, DM-2000, M6000, M7000, SM1, SM2
22. 2K interface
23. YeS computer (via data transmission multiplexer), M4030 (via UVTL-M [telegraph information input/output device])

Later the use of the hardware discussed and of other promising hardware will make it possible to organize in the Belorussian Railroad a ramified data processing and computing network making possible collective access of users to the most varied information concentrated in the memory of any computer, which will improve still more the efficiency of on-line control of the transportation process.

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PROBLEMS OF DESIGN AND DEVELOPMENT OF COLLECTIVE-USE COMPUTER CENTERS AND SYSTEMS

Kiev UPRAVLYAYUSHCHIYE SISTEMY I MASHINY in Russian No 3, May-Jun 82 pp 126-127

[Article by Candidate of Economic Sciences Anatoliy Arkad'yevich Ilyukovich, Belorussian Branch of VGPTI, USSR TsSU,and Candidate of Technical Sciences Svyatoslav Mikhaylovich Zveryugo, Minsk]

[Text] The fourth All-Union Scientific and Technical Conference "Problems of design and development of collective-use computer centers and systems," organized by the USSR GKNT [State Committee for Science and Technology], USSR TsSU [Central Statistical Administration] and the Belorussian SSR TsSU, VNIIPOU [expansion unknown] and the Belorussian branch of VGPTI [All-Union State Design-Technological Institute for Mechanization of Accounting and Computers] on mechanization of accounting and computer work of the USSR TsSU and also the republic VTsKP [collective-use computer center] of the Belorussian SSR TsSU, was held in Minsk from 20 through 22 October 1981.

More than 500 persons from all the Union Republics of our country participated in the work of the conference. The representatives of more than 200 organizations from 46 cities gave reports and participated in discussion of the problems of developing collective-use computer centers and systems.

A total of 11 reports of managers and leading specialists was heard at the Plenary Session of the conference.

In his main report B. G. Sanyaninov (USSR GKNT, Moscow) generalized the results of development of GSVTs [state network of computer centers] during the 10th Five-Year Plan and determined the basic directions of its development for 1981-1985 and for the period up to 1990. The reporter outlined the scientific and technical policy and the state plan for development of existing and creation of new VTsKP during the 11th Five-Year Plan and also informed the conference participants of the developed system for coordination and management of all developments on the problem of GSVTs in the country on the p rt of USSR GKNT.

The report of E. V. Yevreinov (VGPTI, USSR TsSU, Mosc was based on theoretical and experimental design developments of the inst te and was devoted to substantiation of an essentially new approach to solution of the problem of

developing a user network of VTsKP based on distributed micromachine systems are finding ever-broader application for development of automated low-level data processing systems (rayon-level ASOI, institution ASOI and ASU of enterprises and associations).

N. V. Kononov's report (Belorussian Branch of VGPIT, USSR TsSU, Minsk) emphasized the timeliness of converting from autonomous computer centers to development of a distributed computer network of the Belorussian SSR TsSU and sectors of the republic's national economy. The basic directions of work of the Belorussian Branch of VGPI for the 11th Five-Year Plan were outlined in standardization of planning decisions on organizational-economic, technical, program, information and production support of computer systems with regard to the experience of the city of Minsk in designing the first unit of the VTsKP.

V. N. Kvasnitskiy's report (VNIIPOU, Moscow) presented a classification of VTsKP under development by types of problems being solved, the role and place in the management system of the country's national ecnomy and indicated their main characteristics that determine the methodology of developing them. The reporter emphasized that management bodies repensible for coordinated economic and social development of a region must be connected to VTsKP as users during development of the second unit to enhance the effectiveness of managing a region--the main purpose of developing VTsKP. Regional ASU should be created on the basis of VTsKP and the second unit of the VTsKP should be regarded as the technical base of the republic, kray or oblast ASU.

G. D. Smirnov's report (Scientific Research Institute of Computers, Minsk) was devoted to consideration of the capabilities of basic hardware and software of the Ryad-2 YeS EVM [Unified Computer System] for development of local collective-use computer systems.

The remaining plenary reports were devoted to problems of creation and development of software, management of resources, experience of developing individual VTsKP, organizational and ecnomic and other aspects of development of VTsKP.

The conference program included 195 reports and communications which were considered at sessions of the following six sections:

--methodology of design and economic and organizational-legal problems of development of VTsKP;

--user problems and improvement of regional management based on VTsKP;

--hardware of VTsKP;

--software of VTsKP;

--technology and information support of VTsKP;

--user netowrk of VTsKP and RVS [distributed computer network].

The considered reports and communications were scientific and practical in nature and touched on the more timely aspects of design, development and operation

of VTSKP and their interaction with users. Recommendations were made on generation of economic incentives funds to increase the efficiency and quality of VTSKP operation.

The conference participants noted that during the time since the Third Conference on Collective-Use Computer Systems, Centers and Networks, the scientific and practical bases for design of a network of computer centers have been determined and formulated more clearly. Seven experimental VTSKP were turned over for industrial operation during the 10th Five-Year Plan and are functioning successfully, experience was accumulated in solving user problems under collective-use conditions of computer equipment, specific work was carried out in improvement of regional management based on VTSKP, a number of documents that regulate the economic and management activity of VTSKP was developed and introduced and the software and hardware of the YeS EVM that permit efficient use of computer resources in different operating modes of VTSKP were checked in practice.

Such progressive forms of making services available to users as development of automated data banks and supplying information users with terminal devices, which made it possible to increase the operational nature and reliability of information offered to users, were introduced at VTSKP developed during the 10th Five-Year Plan.

More improved technology of information processing was created at VTSKP (unlike individual computer centers), which requires allocation of work in design of new forms of information processing technology in an independent scientific direction. The need to intensify work in development of methods and means of simulating the functional processes of VTSKP and in investigation of problems of development in operation of integrated collective-use information stocks was emphasized.

Problems of the methodology of design of distributed computer systems, their software and information support, technology of parallel processing of information and use of these systems as the user network of VTSKP were postulated and discussed for the first time at the conference.

It was noted in the talks of the conference participants that the most important questions that regulate the economic and management activity of VTSKP have not been fully resolved and legally formulated up to the present time. It was also noted that several versions of different software systems, including different data base control systems, information teleprocessing systems and computer process control systems, are being operated at VTSKP. Comparative analysis of them has not been carried out until now and specific recommendations have not been developed on their use as a function of the type of VTSKP and the nature of the problems being solved. Work on standardization of user problems and standardization of problems for solving them is not being conducted.

As before, the different ministries and agencies are developing their own individual computer centers within the sphere of influence of VTSKP, which results in dispersion of forces and computer capacities on a sector and regional scale. Enterprises and organizations in the sphere of material production are insufficiently represented among users of VTSKP.

The characteristic feature of work during the 11th Five-Year Plan in development of VTSKP is the planned nature of research and design-technology work conducted within the framework of a specific complex scientific and technical program which envisions organization of 22 new VTSKP and development of existing ones.

Based on the experience of development and operation of experimental VTSKP, the conference participants feel that the primary tasks are solution of problems of the economic and management activity of VTSKP, development of indicators of the production and economic activity of VTSKP and of norms, an increase of labor productivity during information processing at VTSKP, expansion of the nomenclature of services offered, an increase of quality and reduction of the cost of information processing.

Development and production of intelligent terminals oriented toward application in VTSKP is also necessary, which will permit an increase in the utilization efficiency of VTSKP and development of the fundamentals of distributed information processing.

The conference participants recommend that the next scientific and technical conference on the given problem be held in 1983 and that school-seminars on individual problems of VTSKP design be held in 1982.

The work of the conference was conducted in a creative business-like atmosphere and in constructive discussion of the problems of development and operati of VTSKP at a high scientific-technical and organizational level.

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PUBLICATIONS

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SYNOPSES OF ARTICLES IN 'AUTOMETRY', MARCH-APRIL 1982

Novosibirsk AVTOMETRIYA in Russian No 2, Mar-Apr 82 pp 116-120

UDC 681.327.2

LASER COMPUTER INFORMATION RETRIEVAL DEVICE IN FORM OF TOPOGRAPHIC FORMATS

[Synopsis of article by V. P. Bessmel'tsev, I. S. Degtyarev, V. P. Koronkevich, V. D. Kosterin, G. I. Jurzin and Yu. N. Tkachuk, pp 3-6]

[Text] The design principles and experimental results on development of a device for retrieval of information from a computer to a carrier subsequently used as topographical format are considered. 4 figures, 4 references.

UDC 535.241.13:537.228

USING SPATIAL LIGHT MODULATORS IN OPTICAL INFORMATION PROCESSING SYSTEMS

[Synopsis of article by A. I. Nagayev, V. N. Parygin and S. Yu. Pashin, pp 6-12]

[Text] The different aspects of using space-time electron beam light modulators (PVMS) based on DKDP ferroelectric crystals in optical information processing systems are considered. The working and operating principles of PVMS are described. It is shown that these PVMS can be used both to correct the light wave front and to create holographic television systems. Experimental results are presented on transmission and restoration of Fourier holograms in real time. 1 table, 5 figures, 5 references.

UDC 621.382.8:681.327(088.8)

PHOTOMATRIX ASSOCIATIVE MEMORY

[Synopsis of article by S. F. Kibirev, S. I. Konyayev and S. I. Naymark, pp 13-19]

[Text] The paper is devoted to development of a photomatrix semiconductor associative memory by p-channel MDP technology. The memory is a homogeneous matrix structure of photo flip-flop cells joined by address, digit and result lines, 12 X 12 bit with distance of 0.3 mm between photodetector centers and with

photosensitivity of 10^{-12} J/bit. The time of performing microoperations is 0.3 μs. Execution of four types of microoperations is outlined to guarantee realization of a wide class of retrieval and arithmetic operations on words comprising the data page in the photomatrix associative memory. 6 figures, 7 references.

UDC 621.035

EFFECT OF PHASE HETEROGENEITIES ON PROPERTIES OF OPTICAL CHANNEL

[Synopsis of article by I. I. Mokhun', V. K. Polyanskiy, V. I. Protasevich and V. V. Yatsenko, pp 19-24]

[Text] The effect of thin phase heterogeneities on the properties of the optical channel of a correlator was investigated. The experimentally derived optimum aperture (OAO) can be used as a criterion of the structure of the phase heterogeneity. 1 table, 4 figures, 4 references.

UDC 535.241.13:681.332

INVESTIGATING A PHOTOELECTOOPTICAL LIGHT MODULATOR IN THE IMAGE PROCESSING MODE

[Synopsis of article by A. Z. Dun, S. Yu. Merkin, Ye. S. Neznevenko, A. N. Oparin, O. I. Potaturkin, V. I. Fel'dbush and G. P. Shcherbakov, pp 24-30]

[Text] The operation of a photoelectrooptical space-time light modulator as the component of an optoelectronic system in the operational input mode and in preliminary processing of identified images was investigated. The outlining versions realized in this case were analyzed. The use of this modulator in combination with a holographic intensity correlator, on the basis of which the system is developed, permits one to realize quasi-optimum identification algorithms. The results of experimental investigations are presented. 5 figures, 8 references.

UDC 534.2

EFFECT OF RANDOM PHASE AND AMPLITUDE ERRORS ON IMAGE QUALITY IN ACOUSTICAL HOLOGRAPHY

[Synopsis of article by L. D. Gik, pp 30-35]

[Text] It is shown that the presence of random phase errors leads to a decrease of the brightness of the image of reflecting elements and to the appearance of false signals in sections of space where the reflecting elements were absent. The given quantitative analysis shows that the first effect is significant with phase error of four periods or more. The second effect can also be significant with smaller phase errors if the number of observations points on the hologram is not considerably greater compared to the number of elements resolved on the object itself. The effect of amplitude errors is less significant than that of phase errors. 4 figures, 1 reference.

UDC 621.391:681.3.01

METROLOGICAL SUPPORT OF AN OPTICO-ELECTROMECHANICAL SYSTEM FOR POSITIONING ZENIT-2 AUTOMATIC PHOTOGRAMMETRIC MACHINE

[Synopsis of article by V. A. Ivanov and V. S. Kirichuk, pp 36-41]

[Text] The software and algorithms for metrological measurements of the drive for the Zenit-2 automatic machine, which permits an increase of accuracy (not worse than $\sim 0.15\ \mu m$) in measuring the coordinates of objects, was developed. 3 figures, 3 references.

UDC 681.3.058

ALGORITHMS FOR DIGIT CALCULATION AND MEASUREMENT OF FUNCTIONS OF ONE INDEPENDENT VARIABLE

[Synopsis of article by V. I. Rabinovich, pp 41-48]

[Text] The properties of algorithms for calculation and measurement of monotonic functions of a single independent variable are presented and analyzed. 2 figures, 2 references.

UDC 681.32.05

INFORMATION PROPERTIES OF IMAGES

[Synopsis of article by O. M. Karpova and M. A. Starkov, pp 48-54]

[Text] The conformity of the mathematical model of normal multigradient images to the statistical properties of real images was investigated with regard to noise and numbering errors. Good agreement of the information characteristics of a specific image to the calculated characteristics is shown. Methods of improving the image quality and of increasing the code compression coefficient are planned. 4 tables, 2 references.

UDC 621.396.2:519.2

TWO-STEP PROCEDURE FOR MEASURING TIME INTERVALS BY STATISTICAL TEST METHOD WITH FEEDBACK

[Synopsis of article by V. G. Gaysov and Yu. N. Gorbunov, pp 54-60]

[Text] A two-step procedure for measuring repeated time intervals by the Monte-Carlo method permits an increase of accuracy of digital measurement $n^{1/2}$ to $n^{3/4}$ times compared to the method of one-time counting after n measurements, which reveals an essentialy new reserve for increasing measurement accuracy. 1 table, 1 figure, 5 references.

UDC 621.317.7.085.36:621.317.7.088

PRECISION ANALOG-DIGITAL AND DIGITAL-ANALOG CONVERTERS

[Synopsis of article by V. P. Popov, pp 60-67]

[Text] The problem of reducing the linearity of an analog-digital converter to its resolution by guaranteeing the required linearity of a digital-analog converter is investigated. Three algorithms for calibration of a digital-analog converter, based on calculation of its highest order weights, are analyzed. The principle capability of finding the linearity of a digital-analog converter and at the same time of an analog-digital converter corresponding to 20 bits is shown. A block diagram of precisicn analog-digital and digital-analog converters is presented. 2 tables, 1 figure, 9 references.

UDC 517.518.8

CONSTRUCTING A STABLE SOLUTION OF A POORLY DETERMINED SYSTEM OF ALGEBRAIC EQUATIONS WITH RANDOM ERRORS IN THE INPUT DATA

[Synopsis of article by Yu. Ye. Voskoboynikov and A. A. Mitsel', pp 67-72]

[Text] An algorithm for selecting the regularization parameter that permits one to estimate the value of the parameter that minimizes the mean square error of solving a system using regularization methods is proposed. A numerical example of determining the concentration of gases from solution of a poorly determined system of algebraic equations is presented. 2 tables, 7 references.

UDC 528.56

METHOD OF MANY CALCULATIONS IN DETERMINATION OF FREE FALL ACCELERATION

[Synopsis of article by Ye. N. Kalish, pp 73-77]

[Text] A method of increasing the accuracy of determining the absolute value of the acceleration of gravity on the basis of measuring the parameters of motion (path and time) on many intervals of the trajectory of a freely falling body was considered. Comparison to the traditional method of measurement on two intervals is presented. The prospects for using the method of many calculations is shown on specific examples. 1 table, 4 references.

UDC 778.38:532.529

DETERMINATION OF PARTICLE FLOW VELOCITY BY METHODS OF SPATIAL SPECTRAL ANALYSIS

[Synopsis of article by A. O. Bakrunov and I. V. Shchukin, pp 78-83]

[Text] The structure of the three-dimensional spectrum of a multiexposure image of particle flow is considered. It is shown how the light intensity distribution in the three-dimensional spectrum is related to the characteristic

function of the velocity vector. Examples of determining the particle flow velocity by the spatial-spectral method are presented. 1 table, 3 figures, 7 references.

UDC 681.3.06

REALIZATION OF SUBSET OF IML LANGUAGE FOR ICAM-10 AUTONOMOUS CRATE CONTROLLER

[Synopsis of article by N. M. Bukharov, V. M. Vukolikov and Ye. V. Pankrats, pp 83-85]

[Text] Realization of the subset of intermediate level CAMAC language IML for the ICAM-10 autonomous crate controller is described. Single operators, crate control operators as a whole and declarative operators that support the work of single operators are included in the subset. It is noted that the use of IML language permits a reduction of the deadlines for development of software for experiment automation systems based on CAMAC equipment and guarantees relative independence of the developed programs from the hardware configuration of the system. 3 references.

UDC 776

INCREASING STABILITY OF ELEMENT SIZE IN PROJECTION PHOTOLITHOGRAPHY

[Synopsis of article by V. B. Gurskiy and R. Ye. Pyatetskiy, pp 86-92]

[Text] A method of reducing the instability of element size in projection photolithography, based on measurement of the energy reflection coefficient R at local points and on exposure control H at these points is investigated. It is shown that exposure control by function H(R) calculated previously for a specific substrate-film system permits a reduction of the range of mean rates of development by a factor of 2-3 when working on relief structures, which in turn reduces the instability of element size in approximately the same proportion. 1 table, 7 figures, 18 references.

UDC 519.853.6

CHECKING LINEARITY AND DESIGN OF PHOTODETECTOR CHARACTERISTICS BY USING LIGHT FILTERS WITH UNKNOWN BANDPASS

[Synopsis of article by A. S. Zagoruyko and Yu. V. Troitskiy, pp 93-95]

[Text] It is shown how to check the linearity of the dependence of the output signal of a photodetector on incident light intensity by using two attenuating light filters whose bandpass is initially unknown. If this dependence is nonlinear, the measurement results permit plotting of it. Numerical approximation of the characteristic was carried out on a computer by means of a FORTRAN-program pack to solve problems of minimization of multidimensional functions. The method is illustrated by an example of constructing the characteristics of a silicon photoelement at wavelength of 0.63 μm and a polynomial of fifth power is used for approximation of the characteristics. 2 figures, 4 references.

UDC 621.378

INVESTIGATING RANGE OF FREQUENCY FLUCTUATIONS OF SINGLE-FREQUENCY STABILIZED LASER EMISSION

[Synopsis of article by A. Ya. Nayurov, V. A. Perebyakin and Ye. G. Chulyayeva, pp 95-97]

[Text] The possible causes of frequency fluctuations of single-frequency stabilized lasers are analyzed. The different methods of determining frequency instability are compared on the example of the LG-149-1 device produced serially and the causes of frequency fluctuations of single-frequency stabilized laser emission are determined. Correlation analysis of destabilizing factors is carried out. Methods are proposed for improving frequency instability and the frequency instability of the serially produced LG-149-1 device is improved. 4 tables, 2 figures, 8 references.

UDC 681.32

GENERAL-PURPOSE ALGORITHM FOR MAKING FAST DISCRETE ORTHOGONAL TRANSFORMATIONS

[Synopsis of article by D. A. Denisov and A. B. Orkin, pp 98-101]

[Text] The calculating structure of different algorithms of fast discrete orthogonal transforms is analyzed. A general-purpose algorithm with parametric assignment of the type of transform is suggested. 1 table, 1 figure, 2 references.

UDC 681.326

PULSE DISTRIBUTOR

[Synopsis of article by O. Z. Gusev and N. A. Primanchuk, pp 101-102]

[Text] The development of a CAMAC module designed to shape pulses with arbitrary interval and length is reported. The operating principle of the module is described and a list of instruction operations is presented. 2 tables.

UDC 621.317.73

AUTOCOMPENSATION MEASURING VECTOR ADMITTANCE-VOLTAGE CONVERTERS THAT GUARANTEE REQUIRED POLARIZATION OF INVESTIGATED OBJECT

[Synopsis of article by V. I. Kenzin and S. P. Novitskiy, pp 102-105]

[Text] The design principles of autocompensation measuring converters for converting passive complex values to an active signal while maintaining the required measuring conditions in direct current at specific terminals of the object are considered. The converters guarantee finding of the complex of informative parameters and can be included directly in the composition of the

automated systems developed on the basis of computers for scientific electrochemical and biological investigations. The main metrological characteristics of the measuring converters developed on the basis of serially produced integrated microcircuits are presented. It is shown that comparatively simple and inexpensive vector admittance-voltage converters of class 0.1-0.5 can be designed on the basis of the proposed principles. 2 figures, 7 references.

UDC 537.311.33.082.52

PHOTODETECTOR BASED ON SCHOTTKY BARRIER AND ISOTYPE HETEROJUNCTION

[Synopsis of article by B. S. Vakarov, I. S. Vakarova and V. N. Vishnyakov, pp 105-107]

[Text] The spectral distribution of the photosensitivity of the Au--$n^+Al_xGa_{1-x}As$--nGaS structure with different molar fraction of aluminum (0.2 x 0.7) was investigated. There are three sections with different sign of the photocurrent in the photosensitivity spectra at 300 K. The spectral position of one of the points of inversion of the sign of photocurrent, corresponding to absorption in GaAs, essentially does not change due to the applied voltage, while that of the other point, corresponding to $h\omega$ = 1.65-2.65 eV, i.e., to absorption in $Al_xGa_{1-x}As$, is dependent on the bias. The behavior of photoresponse is easily described by a zone model containing a Schottky barrier and isotype heterojunction with counterdirectional internal electric fields. 3 figures, 9 references.

UDC 681.782.5:681.3

OPTICAL LASER IMAGE RECORDER SYSTEM

[Synopsis of article by A. M. Itigin and T. N. Khatsevich, pp 108-110]

[Text] The optical diagrams for design of two-coordinate laser image recorders (LRI) using two scanning mirrors are described. The results of developing the optical system of laser image recorders with scanning in a parallel beam are presented. 4 figures, 2 references.

UDC 535.241.13

DYNAMIC OUTLINING OF HALF-TONE IMAGES BY PROM TRANSPARENCY

[Synopsis of article by V. F. Trukhin, pp 110-112]

[Text] It is shown that the use of pulsed reading from a PROM transparency with variable power supply and continuous recording of the optical signal permits one to change the visibility of one or another image half-tones up to total suppression of them. Suppression of the selected gradation is controlled by the moment of reading. 1 figure, 4 references.

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